Clouds and the Earth's Radiant Energy System (CERES)

Production Software Development and Implementation Plan

Version 1

for

TRMM, Terra, Aqua, and SNPP

April 2015

Clouds and the Earth's Radiant Energy System (CERES)

Stakeholder-Commitment Sheet for the CERES Production Software Development and Implementation Plan

This Stakeholder-Commitment Sheet is to demonstrate that the relevant stakeholders as identified in Table 2-1 are aware of and support the CERES processes described in the CERES Production Software Development and Implementation Plan.

Primary Contributors

_____ (Tammy O. Ayers)
_____ (Denise L. Cooper)
_____ (Walter F. Miller)
_____ (John L. Robbins)

Review Team

_____ (Tammy O. Ayers)
_____ (Denise L. Cooper)
_____ (Dennis F. Keyes)
_____ (Walter F. Miller)

DMT Lead

_____ (Jonathan L. Gleason)

Subsystem Teams

Instrument	(Denise L. Cooper, Lead)
	(A. Thomas Grepiotis)
	(T. Nelson Hillyer)
	(K. Dianne Snyder)
ERBE-like	(Dale R. Walikainen, Lead)
	(Jeremie Lande)
Clouds	(Sunny Sun-Mack, Lead)
	(Walter F. Miller, Lead)
	(Igor Antropov)
	(Ricky R. Brown)
	(Yan Chen)
	(Rita A. Smith)
Inversion	(Victor E. Sothcott, Lead)
SARB/MOA	(Thomas E. Caldwell, Lead)
TISA Gridding	(Raja I. Raju, Lead)
TISA Averaging	(Cathy Nguyen, Lead)
	(Dennis F. Keyes)
GGEO	(Raja I. Raju, Lead)
CERES Libraries	(T. Nelson Hillyer)
	(A. Thomas Grepiotis)
	(Michael A. Linsinbigler)
	(Joshua C. Wilkins)

CM Team

	(Tammy O. Ayers, Lead)
	(Dennis F. Keyes)
	(Joanne H. Saunders)

Documentation Team

	(Tammy O. Ayers, Lead)
	(Joanne H. Saunders)

Document Revision Record

The Document Revision Record contains information pertaining to approved and completed document changes. The table lists the date the described revision was completed, the Version Number, a short description of the revision, and the affected sections. The document author(s) are listed on the Acknowledgements page.

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Document Revision Record

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Preface

CERES is a key component of EOS and SNPP. The first CERES instrument (PFM) flew on TRMM, four instruments are currently operating on the EOS Terra (FM1 and FM2) and Aqua (FM3 and FM4) platforms, and the FM5 instrument is flying on SNPP. CERES measures radiances in three broadband channels: a shortwave channel (0.3 - 5 μm), a total channel (0.3 - 200 μm), and an infrared window channel (8 - 12 μm). The last data processed from the PFM instrument aboard TRMM was March 2000; no additional data are expected. Until June 2005, one instrument on each EOS platform operated in a fixed azimuth scanning mode and the other operated in a rotating azimuth scanning mode; now all are typically operating in the fixed azimuth scanning mode. The SNPP platform carries the FM5 instrument, which operates in the fixed azimuth scanning mode though it has the capability to operate in a rotating azimuth scanning mode.

CERES climate data records involve an unprecedented level of data fusion: CERES measurements are combined with imager data (e.g., MODIS on Terra and Aqua, VIIRS on SNPP), 4-D weather assimilation data, microwave sea-ice observations, and measurements from five geostationary satellites to produce climate-quality radiative fluxes at the top-of-atmosphere, within the atmosphere, and at the surface, together with the associated cloud and aerosol properties.

The CERES Production Software Development and Implementation Plan describes how the SDT works with the Science Team and the Langley ASDC to build, migrate, and implement the science production code to run in a production environment at the ASDC.

Acknowledgements

This document reflects the collaborative efforts of members of the CERES SDT (in conjunction, as appropriate, with the CERES Science Team). The primary contributors to this document are:

John L. Robbins (SSAI)
Tammy O. Ayers (SSAI)
Denise L. Cooper (SSAI)
Walter F. Miller (SSAI)

Documentation support was provided by the CERES Documentation Team (Tammy O. Ayers (SSAI) and Joanne H. Saunders (SSAI)).

Jonathan L. Gleason (NASA) is the CERES DMT Lead. At the time of publication of this document contractor members of the CERES SDT are:

Igor Antropov
Tammy O. Ayers
Ricky R. Brown
Thomas E. Caldwell
Yan Chen
Denise L. Cooper
A. Thomas Grepiotis
T. Nelson Hillyer
Dennis F. Keyes
Jeremie Lande
Michael A. Linsinbigler
Walter F. Miller
Cathy Nguyen
Raja I. Raju
Joanne H. Saunders
Rita A. Smith
K. Dianne Snyder
Victor E. Sothcott
Sunny Sun-Mack
Dale R. Walikainen
Joshua C. Wilkins

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CERES Production Software Development and Implementation Plan

1.0 Introduction

It is the responsibility of the CERES Science Team to prepare science algorithms to produce fused CERES climate data records which will help to increase the understanding of the Earth's climate and radiant environment.

The CERES project management and implementation responsibility is at NASA Langley. The CERES Science Team is responsible for the instrument design and the derivation and validation of the science algorithms used to produce the data products distributed to the atmosphere and climate modeling communities and to the public. The Science Team is composed of the following seven WGs.

1. Instrument
2. ERBE-like
3. Clouds
4. ADM/TOA Flux
5. Surface-Only Flux Algorithms
6. SARB
7. TISA

The CERES SDT, as per the processes described in this plan, is responsible for the development and maintenance of the software that implements the Science Team's algorithms and for releasing this software to the Langley ASDC, where it will run in a production environment to produce CERES climate data records and other CERES data products. The Langley ASDC is responsible for the production environment, data ingest, and processing, archival, and distribution of the CERES data products as directed by the CERES PI.

The CERES SDT is comprised of subsystem teams that support each of the seven Science Team WGs and of the CM, Documentation, and Process Improvement Teams. Each subsystem is responsible for one or more stand-alone executable programs or PGEs. Each PGE executes when all of its required input data sets are available and produces one or more intermediate or archival science products. In some cases the archival science product may require a series of PGEs to be run in sequence to generate the archival science product.

The purpose of this document is to integrate descriptions of the CERES production software development and implementation processes, LMS-1400 (the Science Directorate's organizational procedure for the "Processing of Global Satellite Science Data"), and the detailed CERES process plans into one document, the CERES Production Software Development and Implementation Plan. This document serves as the CERES Software Management Plan as required by the LMS.

An outline of the document's content follows.

Section 1.0 – Introduction
Section 2.0 – CERES Software Development Process
Section 3.0 – CERES Science Code Implementation Process
Section 4.0 – Processing of Global Satellite Science Data (LMS-OP-1400)

Appendix A – contains a list of acronyms used throughout this document. All acronyms used in this document are defined in Appendix A. They are not defined in the text.

The CERES SDT developed and follows a set of customized processes for developing, testing, controlling, delivering, and maintaining the CERES production science software that is run operationally at the ASDC. The remainding appendices are listed below. They contain a description of each of these key processes used in the development and implementation of the CERES production software.

Appendix B – Configuration Management Plan
Appendix C – Document Management Plan
Appendix D – Measurement and Analysis Plan
Appendix E – Process and Product Quality Assurance Plan
Appendix F – Requirements Management Plan

The processes described in Appendices B through F have been the basis of successful CMMI Class-A Appraisals under two technical support services contracts supporting this work.

The SD contractor responsible for developing and implementing the CERES software in a production environment at the ASDC will be expected to follow the processes for developing and implementing the CERES production software as described in this document and for providing the necessary training on the processes to the appropriate technical staff.

1.1 Compliance with NPR 7150.2A, Chapter 5

In preparing this document, Chapter 5, Software Documentation Requirements, of NPR 7150.2A (see Reference 1) was relied on heavily for guidance to ensure all the items required by NASA are accounted for.

Table 1-1 shows the content required by NPR 7150.2A for this document and where in the document that requirement is satisfied or provides the reason/justification why the requirement was waived/not addressed.

1.2 Organization

The key organizational elements that are involved in the CERES software development and data processing effort are shown in Figure 1-1. The CERES Science Team, including the CERES PI and the science WGs, constitutes the “Science” area. The CERES SDT, including the CERES DMT Lead, the subsystem teams, and the CM, Documentation, and Process Improvement Teams, constitutes the “Software Development” area. Note that each subsystem team is affiliated with one or more science WGs as shown in Table 1-2. Typically, the NASA personnel are located at NASA Langley Research Center in Building 1250, and the contractor personnel

are located in an off-site contractor facility. The computer environment that supports both the Science Team and the SDT in both locations is the *AMI* system physically located at the ASDC (see Section 2.1.3).

The goal of these teams is to prepare software which implements the CERES algorithms as defined by the CERES Science Team as represented in the data flow diagram shown in Figure 1-2 and to execute this software operationally to produce the CERES data products (see Data Products Catalog, Reference 2). Operational data processing is conducted at the ASDC by ASDC personnel.

Table 1-1. Compliance Matrix for NPR 7150.2A, Chapter 5

NPR 7150.2A Chapter 5 Item#	Item	PSD & IP Section#
a	Project organizational structure showing authority and responsibility of each organizational unit, including external organizations (e.g., Safety and Mission Assurance, Independent Verification and Validation (IV&V), Technical Authority, NASA Engineering and Safety Center, NASA Safety Center).	1 & 2
b	The safety criticality and classification of each of the systems and subsystems containing software.	2.1.2
c	Tailoring compliance matrix for approval by the designated Engineering Technical Authority, if the project has any waivers or deviations to this NPR.	NA
d	Engineering environment (for development, operation, or maintenance, as applicable), including test environment, library, equipment, facilities, standards, procedures, and tools.	2.1.3
e	Work breakdown structure of the life-cycle processes and activities, including the software products, software services, non-deliverable items to be performed, budgets, staffing, acquisition approach, physical resources, software size, and schedules associated with the tasks.	Note 1
f	Management of the quality characteristics of the software products or services.	Appendix E
g	Management of safety, security, privacy, and other critical requirements of the software products or services.	2.1.3
h	Subcontractor management, including subcontractor selection and involvement between the subcontractor and the acquirer, if any.	Note 1
i	Verification and validation.	Figure 2-1 Table 2-2
j	Acquirer involvement.	NA
k	User involvement.	NA
l	Risk management.	NA
m	Security policy.	2.1.3
n	Approval required by such means as regulations, required certifications, proprietary, usage, ownership, warranty, and licensing rights.	B-2.1.1

Table 1-1. Compliance Matrix for NPR 7150.2A, Chapter 5

NPR 7150.2A Chapter 5 Item#	Item	PSD & IP Section#
o	Process for scheduling, tracking, and reporting.	B-2.0 D-2.1 D-3.0 D-4.1
p	Training of personnel, including project unique software training needs.	Note 2
q	Software life-cycle model, including description of software integration and hardware/software integration processes, software delivery, and maintenance.	2.1.5
r	Configuration management.	Appendix B
s	Software documentation tree.	Table 2-1
t	Software peer review/inspection process of software work products.	2.5
u	Process for early identification of testing requirements that drive software design decisions (e.g., special system level timing requirements/checkpoint restart).	
v	Software metrics.	Table D-5-1
w	Content of software documentation to be developed on the project.	Table 2-1
x	Management, development, and testing approach for handling any commercial-off-the-shelf (COTS), government-off-the-shelf (GOTS), modified-off-the-shelf (MOTS), reused, or open source software component(s) that are included within a NASA system or subsystem.	NA
Note 1. This is a technical task-level volume that describes the CERES production-software development processes. The software lifecycle is described in Section 2.1.5. Software products are described in the Data Products Catalog (see Reference 2). PGE sizes are discusssed in Appendix B. Otherwise, information regarding this item may be found at the CERES project level through the Science Directorate. Note 2. Training of personnel is generally provided by the SD contractor (see Section 1.0).		

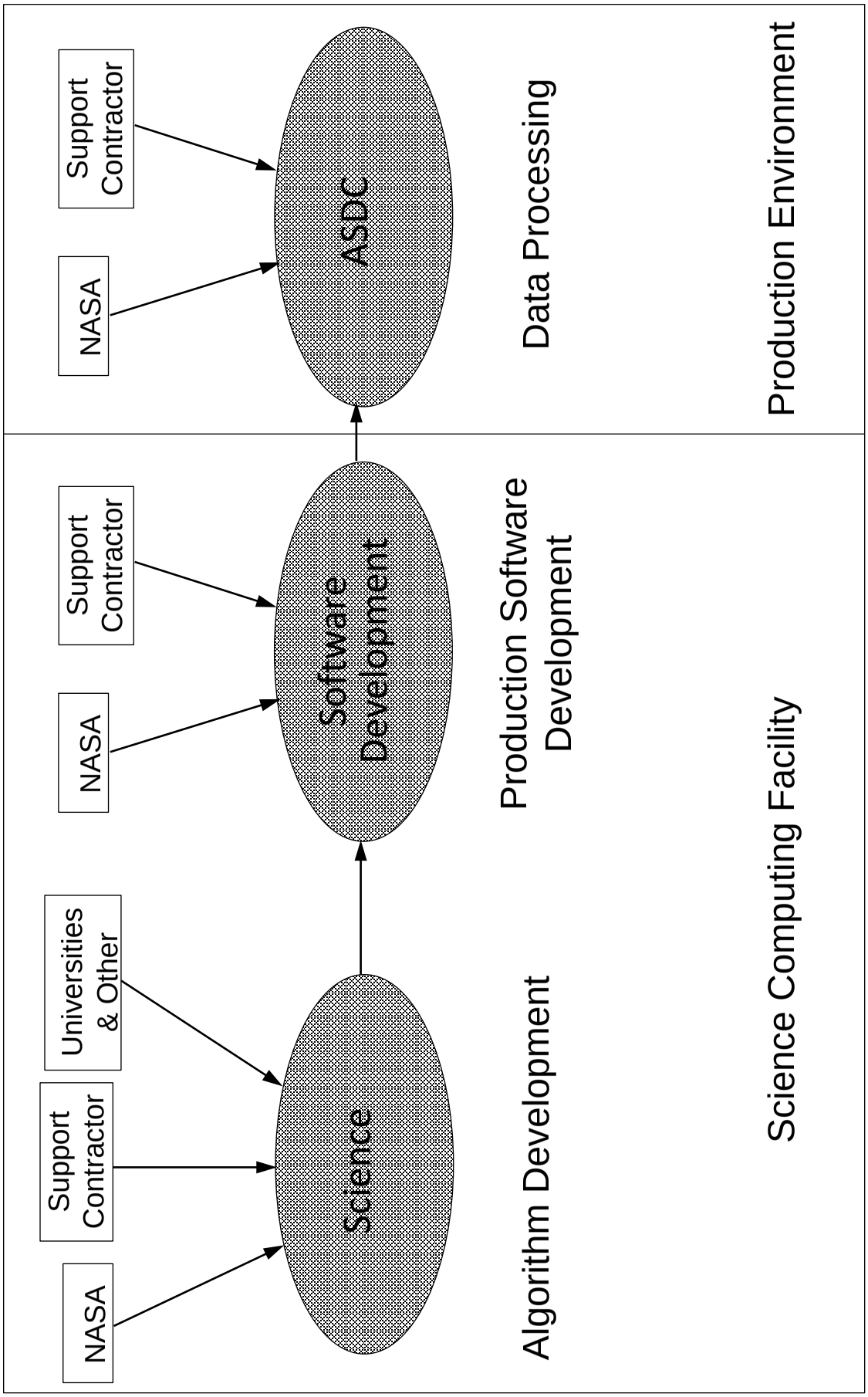

Figure 1-1. Organizational Components for CERES Software Development and Data Processing

Table 1-2. WG/Subsystem Team Organization

WG	Subsystem Team(s)
Instrument	Instrument ERBE-like
Clouds	Clouds
ADM/TOA Flux	Inversion
Surface-Only Flux Algorithms	Inversion
SARB	Instantaneous SARB Synoptic SARB MOA
TISA	TISA Gridding TISA Averaging GGEO

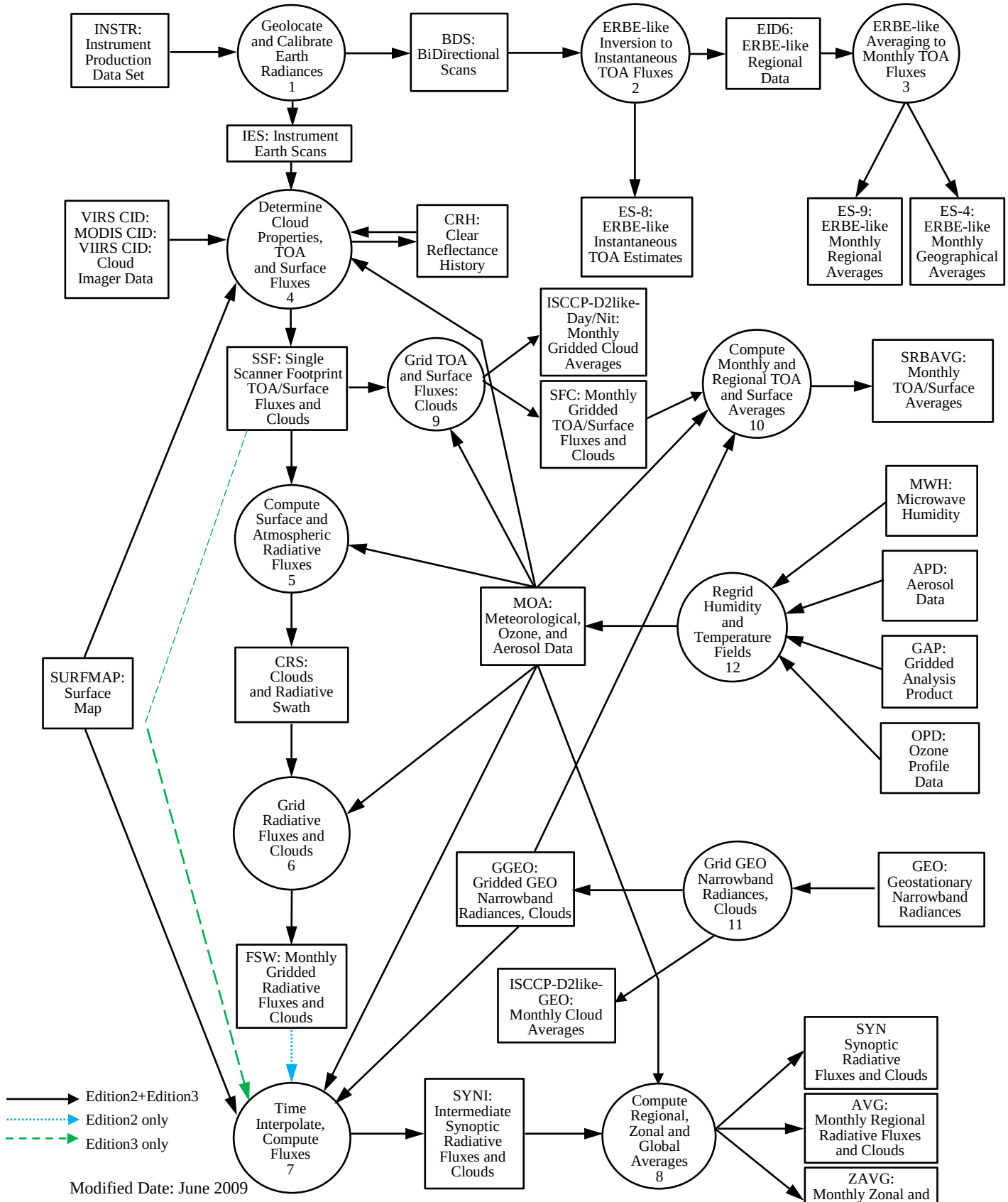

Figure 1-2. CERES Top Level Data Flow Diagram

2.0 CERES Software Development Process

2.1 Background

2.1.1 CERES Software Development Process Flow

Section 2 defines the processes followed by the CERES SDT while developing, testing, controlling, delivering, and maintaining the CERES production science software to run operationally at the ASDC. Additional documents associated with the project provide information regarding data interfaces, processing algorithms, output products, instrument design and calibration, and product validation as they were developed through the project life cycle. These documents are accessible through the CERES On-Line Documentation page (see Reference 3). The CERES software development process flow can be seen in Figure 2-1. Each step is described in detail in Section 2.2 through Section 2.4. The assignment of responsibility for each stage and other associated stakeholders can be found in the Stakeholder Matrix for CERES Production Software Development shown in Table 2-1 which includes Software Development Flow, Supporting Documentation (or Documentation Tree), and Supporting Activities. Peer reviews, as used by CERES, are discussed in Section 2.5.

2.1.2 CERES Software Classification

The CERES software that comprises the CERES data processing system is Class C – Mission Suppport Software (see Reference 1). As described in Section 2.1.2.1, the existing CERES software should also be considered as "heritage" or "legacy" software as it is based on the ERBE data processing system.

2.1.2.1 ERBE Heritage

ERBE was a multi-satellite system designed to measure the Earth's radiation budget. The ERBE instruments flew on a low-inclination NASA satellite (ERBS) and two sun-synchronous satellites (NOAA-9 and NOAA-10). Each satellite carried both a scanner and a nonscanner instrument package.

ERBE software and concepts were reused by the CERES software development team. For example, the CERES Inversion and TISA Subsystems relied heavily on reused ERBE code. CERES also derived much of the initial set of CERES documentation and documentation standards from the documentation set developed for the ERBE project. A complete list of CERES Documentation can be found on the CERES On-Line Documentation Website (see Reference 3).

One of CERES four main objectives is "For climate change analysis, provide a continuation of the ERBE record of radiative fluxes at the TOA, analyzed using the same algorithms that produced the ERBE data" (see the CERES Brochure, Reference 4). To this end the ERBE Inversion and TSA Subsystems' (combined scanner and nonscanner) software was actually used as the basis of the new CERES ERBE-like Subsystems. Some of the considerations in converting the ERBE to CERES ERBE-like code follow.

- Remove nonscanner instrument data processing code
- Port code from the Network Operating System to a Unix platform
- Modify code to reflect the CERES, rather than the ERBE, instrument sampling rate

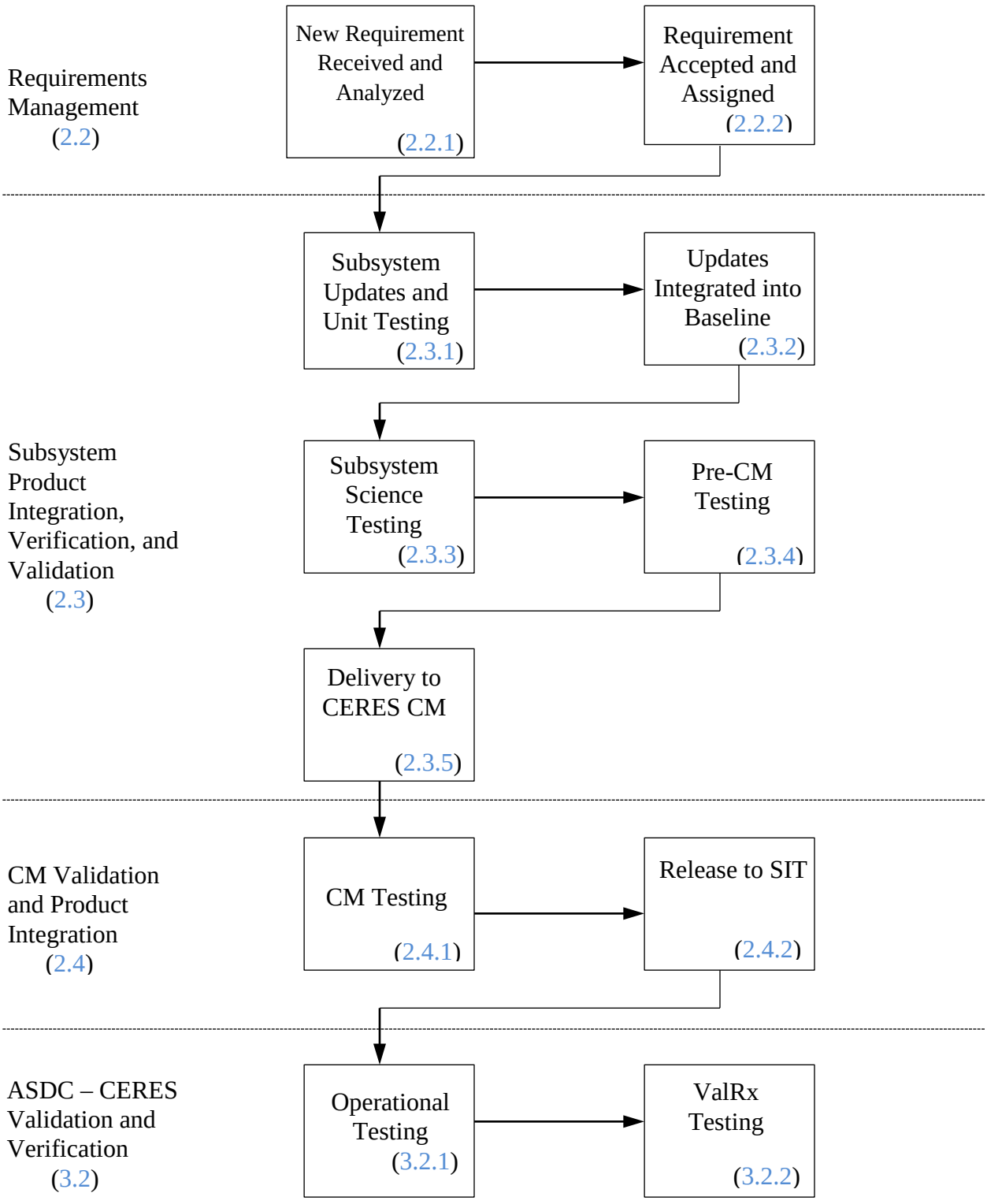

Figure 2-1. CERES Software Development Process Flow Diagram

Table 2-1. Stakeholder Matrix for CERES Production Software Development

	CMMI Process Area[1]	ST	DMT Lead	CERES Systems Grp Mgr	Contractor Technical Manager	SS SDTs	CM Team	Doc Team	QA Team	ASDC
Software Development Flow										
New Requirement Received and Analyzed	REQM	S	S			R				
Requirement Accepted and Assigned	REQM	S				R				
Updates made and Unit Tested	VER	S				R				
Updates Integrated into Baseline	PI					R				
Subsystem Science Testing	VER & PI	S				R				
Pre-delivery Testing	VAL					R				
Delivery to CERES CM	PI					R	S	S		
CM Testing	VAL					S	R			
Release to SIT	PI						R			S
Operational Testing at ASDC	VAL									R
ValRx Testing at ASDC	VAL & VER	S	S			S				R
Supporting Documentation (or Documentation Tree)										
Biweekly Reports for CPOB meetings	PMC					R		R		
CPOB Meeting Minutes	PMC						R	R		
Data Products Catalog	PI		S			R	S	S		
Delivered Files Tracking Document	PMC						R			
Delivery Memos	CM	S	S			R	S	S		
File Management Policy	PMC					S		R		S
Monthly Task Status Report	PMC	S	S	S	S	R	R	R	R	
Operators' Manual	PMC					R		R		
Production Software Development & Implementation Plan	All		R	S	S	R	R	R	R	S
QA reports	PPQA		S	S	S				R	
QStats Report	MA		R				R			
Requirements Logs	REQM					R				
SCCRs	CM	S	S			R	S			S
Software Computer Bulletins	All		R		S	S	S	S	S	
Software Coding Guidelines	All		R			S	S	S		
Technical Responses (TRs)	PP & PMC	S	S	R	S	S	S	S	S	
Test Plans	VAL					R	S	S		S
TRL	VAL					S	R			
Open SCCR Table for the CPOB Meeting	PMC		R							
Supporting Activities										
Approval of "Science Data Products" for Archival and Distribution	PMC		R							
Document Support	PMC							R		
Prepare, utlilize, update, and maintain software for measuring LOC counts.	PMC	S	S			S	R			
Update and maintain delivery schedule	PMC		R				R			

R – Responsible Party
S – Stakeholder

1. The Process Area(s) shown in the "CMMI Process Area" column is not necessarily the only Process Area associated with the particular document or activity.

- Modify code to spectrally unfilter the longwave window channel
- Modify code to use the SDP Toolkit

"ERBE-like Products are as nearly identical as possible to those produced by the previous generation ERBE instruments. These products include broadband shortwave, longwave, and net radiative fluxes for both cloudy sky and clear sky conditions. ERBE-like products are used for climate monitoring and climate change studies when comparing directly to ERBE data sources" (see Reference 4).

2.1.3 Engineering Environment

The Science Team derives, maintains, and refines science algorithms to produce climate-quality data products from the CERES instruments to characterize global climate change; the SDT implements these research science algorithms as operational software to be run at the ASDC. The CERES operational software development environment is the SCF. The CERES software resides at the SCF where it is backed up and protected from outside attack. Only the executables, as opposed to production source code, are maintained in the production environment. Both the production and development environments are contained on the *AMI* system as illustrated in Figure 2-2.

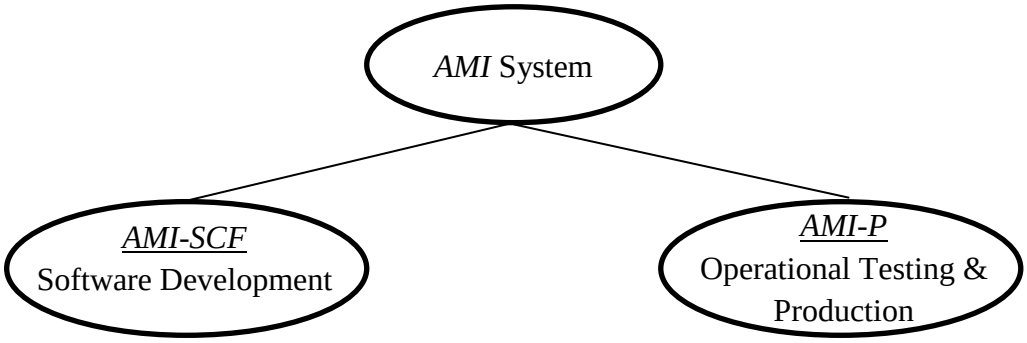

Figure 2-2. *AMI* System Overview

The ASDC maintains the *AMI* system (see Reference 5) which provides the engineering environment for the CERES SDT in support of the following CMMI process areas.

- Product Integration under which Specific Practice 1.2 is to "Establish and maintain the environment needed to support the integration of the product components".
- Validation under which Specific Practice 1.2 is to "Establish and maintain the environment needed to support validation".
- Verification under which Specific Practice 1.2 is to "Establish and maintain the environment needed to support verification".

The *AMI* system is always available unless it is unexpectedly down or down for maintenance. This is a Government-provided and -maintained computer system. No coordination is needed with the ASDC for installations/compilations using this system.

The ASDC provides the capability to ingest and process CERES and ancillary data records and to archive and disseminate the resulting climate-quality data products.

The NASA Langley Research Center (LaRC) Atmospheric Science Data Center (ASDC) Information Technology System Security Plan (SC-011-M-LRC-3000) is the security plan for the SD servers including the *AMI* system. This plan discusses the management of safety, security, privacy, and other critical requirements of the software products (including the CERES production software) and services for disseminating these products.

2.1.4 CMMI Process Areas Mapped to CERES

Table 2-2 shows the CMMI process areas associated with each of the CERES software development steps as contained in Figure 2-1, which working level or organization (Process Environment) performs it, and in which computer environment the process is performed.

For reference the definitions of the Requirements Management, Product Integration, Verification, and Validation CMMI process areas are given below (see Reference 6).

The purpose of **Requirements Management** is to manage the requirements of the project's product and product components and to identify inconsistencies between those requirements and the project's plan and work product.

The purpose of **Product Integration** is to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product.

The purpose of **Verification** is to ensure that selected work products meet their specified requirements.

The purpose of **Validation** is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment.

Table 2-2. Mapping of CERES Processes to CMMI Process Areas

Section	CERES Process[a]	Process Environment	CMMI PA	Computer Environment
2.2.1	New Requirement Received and Analyzed	Subsystem	Requirements Management	*AMI-SCF*
2.2.2	Requirement Accepted and Assigned	Subsystem	Requirements Management	*AMI-SCF*
2.3.1	Subsystem Updates and Unit Testing	Subsystem	Verification	*AMI-SCF*
2.3.2	Updates Integrated into Baseline	Subsystem	Product Integration	*AMI-SCF*
2.3.3	Subsystem Science Testing	Subsystem	Product Integration Verification	*AMI-SCF*
2.3.4	Pre-delivery Testing	Subsystem	Validation	*AMI-P*
2.3.5	Delivery to CERES CM	Subsystem	Product Integration	*AMI-SCF*
2.4.1	CM Testing	CM	Validation	*AMI-P*
2.4.2	Release to SIT	CM	Product Integration	*AMI-P*
3.2.1	Operational Testing[b]	ASDC	Validation	*AMI-P*
3.2.2	ValRx Testing	ASDC	Validation Verification	*AMI-P*

a. From Figure 2-1.
b. Informational only, Operational Testing is not a process performed by the SDT.

2.1.5 CERES Software Development Lifecycle

The CERES SDT basically follows an iterative Waterfall lifecycle approach in their software development activity. Each iteration produces a different version of the software that will produce a new version of one or more of the CERES data products. Small changes in the software are reflected by incrementing the Configuration Code (see Reference 7) for associated CERES data products. More significant changes to the software are reflected by using a different Production Strategy or incrementing a Production Strategy currently being used, i.e., Edition1 → Edition2 (see Reference 7).

This view may be somewhat obscured as the SDT has multiple, independent software development sub-teams or subsystem teams that work with the CERES Science Team WGs as described in Section 1.0 of this document. Each subsystem team's schedule for meeting the release of a new software version is dependent on the research agenda for the particular CERES Science Team WG that the subsystem team supports.

It is of interest to note that from time to time, when cost estimation software is used by the CERES team (see Reference 8), very typically the lifecycle selected to represent the CERES software development approach is the Spiral model with 1 or more loops. However, considering the time offset in the implementation of new software versions that is introduced by multiple software development teams, coupled with the research nature of the CERES science software, there really isn't a model that exactly describes the CERES software development lifecycle. That being said, based on the SDT's experience, a description of the CERES software development lifecycle follows.

The Software Requirements Documents (see Reference 9) served as a basis for the initial software design as described in the CERES Software Design Documents (see Reference 10) and initial development of the CERES subsystem production software. These requirements were derived from the Algorithm Theoretical Basis Documents (see Reference 11).

The Waterfall-like lifecycle approach that led to this initial software version was

Requirements (Science and Software) →
Software Design →
Software Development →
Testing →
Software Implementation and Production of CERES Data Products →
Evaluation of Software Performance and of Science Data Products →
Maintenance.

Each of the CERES subsystem teams follows the above process in accordance with technical direction from their respective Science Team WGs. As a result of the software and data product evaluation, the various WGs identify improvements to the science algorithms which are provided to the subsystem software teams as requirements in accordance with the Requirements Management Plan (see Appendix F). With these new requirements the Waterfall-like process repeats.

2.2 Requirements Management

The CERES Requirements Management process consists of receiving, logging, analyzing, implementing, and tracking requirements from the CERES Science Team for creating and updating the CERES production software. Requirements Management is broken into two tasks as shown in Figure 2-1: New Requirement Received and Analyzed (see Section 2.2.1) and Requirement Accepted and Assigned (see Section 2.2.2).

Since the publication of the ATBDs and for as long as new data sets are produced, new requirements for the CERES processing system continue to be generated. The requirements for modifications may come from the CERES Science Team, the DMT Lead, or be driven by outside influences such as new or updated systems. New requirements are entered into the subsystem-level requirements log and managed according to the CERES Requirements Management Plan (see Appendix F). The receipt of a new requirement initiates the process of preparing for a subsystem software delivery to the ASDC.

2.2.1 New Requirements Received and Analyzed

A new requirement can be communicated in various methods, such as email, a face-to-face meeting, during a Science Team or CPOB meeting, or over the phone. These requirements are then entered into the appropriate subsystem's Requirements Log as per the Requirements Management Plan (see Appendix F). In conjunction with the Requirements Log an SCCR is created whenever a new requirement is added that may lead to an update to or creation of a new PGE. Further information on how to create/update an SCCR can be found in the CERES CM Plan (see Appendix B). The requirements are then analyzed to determine what impact the change will have on the delivery schedule, data product size, processing time, and available memory. The affect of the change on other subsystems and data products needs to be communicated to other subsystems and to the DMT Lead. The analyst should consider if their subsystem is the best place to meet the requirement.

2.2.2 Requirement Accepted and Assigned

The results of the requirement analysis will be given to the requirement provider, who has the option of authorizing the software update or not. If the requirement is not authorized, the appropriate subsystem's Requirements Log is updated to reflect this decision. Otherwise, the subsystem lead will assign an analyst to implement the change as described in the next section.

2.3 Subsystem Product Integration, Verification, and Validation

Subsystem product integration, verification, and validation consist of the processes followed by the subsystem team after the receipt, analysis, acceptance, and assignment of a new requirement to implement and deliver the updated product (CERES subsystem software) to CERES CM. The subsystem product integration, verification, and validation are broken down into five tasks as shown in Figure 2-1: Subsystem Updates and Unit Testing (see Section 2.3.1), Updates Integrated into Baseline (see Section 2.3.2), Subsystem Science Testing (see Section 2.3.3), Pre-delivery Testing (see Section 2.3.4), and Delivery to CERES CM (see Section 2.3.5).

At the subsystem level a new requirement results in new software being developed or existing software being changed by an analyst. Once the changes are made, limited testing is performed to confirm that the changes are correct and meet the specified requirements. This is the first part

of CERES subsystem verification described in Section 2.3.1 and shown in Figure 2-1. The modified code is then passed to the subsystem integrator for incorporation in the current baseline.

The subsystem product integration process ensures that the assembled product functions properly. The first part of CERES subsystem product integration consists of the integration of updates made to one or more modules into the subsystem's software baseline. It is the responsibility of the subsystem team to update the individual modules and deliver the tested updates to the subsystem's integrator for integration into the baseline. This process encompasses the task described in Section 2.3.2 as shown in Figure 2-1.

CERES subsystem science testing described in Section 2.3.3 as shown in Figure 2-1 falls under both the Product Integration and Verification process areas. The subsystem science testing is to ensure that the new or modified software, as integrated, functions properly (Product Integration - more of a solely SDT activity) and to ensure that it meets the specified requirements (Verification - more of a joint SDT and Science Team activity), in this case by using more complete test data sets than are available when performing unit testing. The subsystem science testing consists of performing a suite of tests determined by the scope of the updates being delivered for incorporation into the subsystem's software baseline. These tests are designed to determine if the new baseline creates the scientific results consistent with the requirements and acceptable to the WG chair. This effort involves the subsystem team and the appropriate WG chair. Subsystem science testing may also include peer reviews (Verification) of the updated software modules; peer reviews are discussed in Section 2.5 of this document.

The subsystem validation process ensures that the product will function in the ASDC production environment. It is possible that downstream subsystems may also be involved in this validation effort, as results of changes made to the science software may unexpectedly affect downstream subsystems. This process encompasses the tasks discussed in Section 2.3.4 as shown in Figure 2-1.

Delivery to CERES CM is the final step in product integration as described in Section 2.3.5 as shown in Figure 2-1.

2.3.1 Subsystem Updates and Unit Testing

Subsystem updates begin when a software change requirement is received and accepted. The analyst will work with the requirement provider on Science Team-contributed software (see Section 2.3.1.1) or on SDT-developed software (see Section 2.3.1.2). After the changes are completed, the software will be unit tested (see Section 2.3.1.3).

Any changes to the CERES production code are first implemented at the SCF and tested by the appropriate subsystem team. Changes that are known or anticipated to impact an interface between subsystems are agreed upon by the Science Team and SDT before implementation. Testing between the impacted subsystems is coordinated by the subsystem leads.

2.3.1.1 Science Team-Contributed Software

Many algorithms are provided to the SDT as already coded modules developed by the Science Team while deriving the science algorithms. For this contributed software the job of the SDT

analyst is to incorporate the code into the subsystem software with minimal changes (see Section 2.3.1.1.1). Examples include software developed to manage the inputs to and outputs from the contributed software. The only changes made to the provided modules by the SDT are those necessary to make the modules function in the ASDC production environment or to conform to CERES standards (see Section 2.3.1.1.1). This allows the Science Team to maintain a parallel version for further refinement and for any changes to be easily communicated to and implemented by the SDT.

2.3.1.1.1 Standardize Contributed Code

Software contributed by the Science Team does not always need to be modified by the SDT. However, modifications must be made when the contributed software does not conform to CERES standards (see Reference 12) or does not function as expected once incorporated into the subsystem software. When modifications are necessary, the updates are discussed with the software provider to ensure that they are aware of the modifications being made and to allow the provider to make many of these modifications to future deliveries of updates to the software. Updates related to the SDP Toolkit will be made by the subsystem team.

In addition, the following checks or changes are made to all software that will execute in the ASDC production environment:

- Replacement of non-Toolkit open and close utilities with Toolkit-provided and/or CERESlib utilities.
- Replacement of non-Toolkit error message utilities with Toolkit-provided and/or CERESlib utilities.
- Replacement of logic that results in underflow or overflow conditions.
- Replacement of logic that does not successfully compile or properly link to libraries used by the subsystem software.

2.3.1.1.2 Conveyance of Modifications to the Science Team

The SDT must convey any modifications that were necessary to the contributed software to the Science Team. This does not place any requirements on the Science Team to incorporate the updates into their version of the software.

2.3.1.2 SDT-Developed Software

The SDT has the responsibility of providing the framework in which the scientific algorithms will function. The framework consists of software that reads input data sets and ancillary data, sequences the science algorithms, provides the necessary input, and writes output files. Within this framework are the data product interfaces that are maintained in CERESlib to ensure multiple subsystems have a consistent interface. Generally, the SDT will develop software that performs quality assurance of the data and generates quality control reports. Additionally, some algorithms are provided through the ATBDs or other communications, and the SDT is required to develop the software. Quality assurance and control in addition to algorithm development requires communication with the Science Team to ensure their expectations are met.

2.3.1.2.1 Required Software Attributes

Software developed or modified solely by the SDT is held to a higher standard than Science Team contributed code. It must meet the Software Coding Guidelines (see Reference 12) as well

as meet requirements for executing in the ASDC production environment (see Section 2.3.1.2.2). All SDT-developed code will include the CERES prologue as per CERES Software Bulletin 95-04 (see Reference 13).

2.3.1.2.2 ASDC Production Environment Requirements

All software that executes in the ASDC production environment needs to satisfy the following requirements at a minimum:

- All contributed code must comply with Section 2.3.1.1.1.
- All data products will use CERES default values when valid data is not produced.
- Range checking will be performed on all data parameters.
- Metadata files (.met) will be produced for all data products that are archived by the ASDC or used by more than one subsystem.

2.3.1.2.3 Data Product Interfaces

Each data product interface between subsystems will be included in a module that is part of CERESlib. Each of these modules will contain the data structure for the header and a data record, file open with and without Toolkit functions, header read, record read, data parameter ranges, header formatted write routine, data record formatted write routine, and file close with and without Toolkit functions.

2.3.1.3 Unit Testing

Unit testing is performed by the analyst assigned the responsibility of implementing the new requirement. This limited testing may be performed only on the module or package that is changed. Due to the complexity of the CERES software, it is not always efficient to perform tests on individual routines outside of the entire subsystem. In these cases the unit test may be performed in the analyst's test area using an updated set of baseline code. Unit tests are considered complete when the results of testing in the analyst's test area are successful. In some cases, the subsystem's WG chair may be involved in the approval of the test cases.

2.3.1.3.1 Testing of Contributed Software

Testing of the Science Team contributed software is frequently conducted with specific input data conditions. The expected results for these specific input conditions must be conveyed to the SDT by the Science Team.

2.3.1.3.2 Testing of Developed Software

Testing of developed software relies more on the subsystem team to determine suitable test cases and expected results especially during unit testing. The Science Team may only be involved on that portion of testing directly related to the coded algorithm.

2.3.2 Updates Integrated into Baseline

Once the code modification is completed and confirmed to be operating correctly, it is delivered to the subsystem integrator. Due to the size of the SDT, it is possible that the team member making the update and the subsystem integrator are one and the same. Each subsystem with more than one individual will have procedures for notifying the subsystem integrator that the software is ready, which parts have changed, and how to obtain the software.

2.3.2.1 Updating Baseline

An environment is provided for software development at the ASDC that, as nearly as possible, is identical to the production environment in processors, operating systems, compilers, and COTS software (see Section 2.1.3). The subsystem integrator will have the latest software baseline in the subsystem integration and test directory on *AMI-SCF*. Modules or packages that have been updated will replace the existing ones. After setting the standard CERES environment variables the code will be compiled. The integrator will work with the analyst to resolve any compilation errors. Once the code has been successfully compiled, the baseline update is completed.

2.3.2.2 Integration Testing

Integration testing is performed by the subsystem integrator in a designated test area determined by the subsystem on SCF resources. The software will be run through a series of standard tests developed by the subsystem along with specific tests to exercise the updated software. The first step is to replicate any expected results provided in unit testing. A routine set of integration tests will be run, which may include first and last day of year tests, a test for February 29, and seasonal tests. In each case a definition based on the requirement will be used to determine if the desired results were achieved. Once functionality is confirmed, further testing is performed during subsystem science testing.

2.3.2.3 Maintaining a Baseline

Each subsystem is responsible for maintaining a repository which contains the approved software baseline. The subsystem integrator is responsible for updating and maintaining the repository. Subsystems may use a configuration management tool to aid in maintaining the baseline; however, the use of a configuration management tool is not required. Maintaining a separate directory structure containing the baseline version of the subsystem software is also acceptable, as long as that directory is in an area that is backed up on a regular basis and procedures for maintaining and updating the baseline are in place for the subsystem. If problems are discovered during testing, updates are made to the baseline to address these issues. The software version that successfully passes all subsystem, CM, and ASDC testing and has been promoted to the operational production environment becomes the starting baseline for the next delivery.

2.3.3 Subsystem Science Testing

The SDT often must test software using a wider variety of input data conditions than are available in the more routine Integration Testing (see Section 2.3.2.2). The Science Team is encouraged to assist in the selection of the input data used during this phase of testing.

For each test the results are compared to expected results that are defined by the requirements. Due to the research nature of the CERES project, it is often necessary to run various subsystem science integration tests and have the results reviewed by the appropriate CERES WG chair. Sometimes the results from the downstream subsystem may be used to verify the previous subsystem's software changes. For example, the Instrument Subsystem passes test results on to the ERBE-like Subsystem to create reports used by the Instrument Subsystem WG chair for verification of the Instrument software updates.

Also, the interface with the downstream subsystem must be tested to ensure that the incoming data product can still be read and does not cause the downstream subsystem's software to fail.

Additional software tools not intended for the production environment have been developed for verification purposes. These tools are designed to analyze the contents of the data products generated by the subsystems. The functions of these tools include, but are not limited to, range verification and comparisons against baseline data. These tools are also provided to the ASDC SIT team with the software deliveries to help evaluate the success of integrating the subsystem into the production environment.

Approval of the software updates by the subsystem WG chair constitutes the end of the Subsystem Science Testing and the software now moves into pre-delivery testing.

2.3.4 Pre-delivery Testing

Pre-delivery testing begins once the subsystem's WG chair approves the results of the subsystem science testing. Pre-delivery testing is performed on the *AMI* system, and therefore this is a validation process. Pre-delivery testing begins by moving the delivery package (software and input, ancillary, and expected output data) into the subsystem's designated test area on the *AMI* system. The pre-delivery testing must follow the subsystem's Test Plan (see Reference 14), however, it is not limited to only those test cases. It is left to the discretion of the subsystem team to determine if test cases not defined in the subsystem Test Plan are run. These test results are compared to results obtained during subsystem science testing. If the test results are scientifically equivalent to that output, the process to deliver the updated software begins.

2.3.5 Delivery to CERES CM

The subsystem team is responsible for delivering the updated software to CERES CM.

Table B-2-3 describes the five delivery categories. The delivery process is described in Section B.5-1.

The Sample Read Package is provided to the ASDC User Services and is distributed to a user when a CERES data product is ordered from the ASDC (see Reference 15). Guidelines on the content to be included in the Sample Read Package are defined by the ASDC User Services (see Reference 15).

The documentation included with Full Subsystem, PGE(s) Specific, and Delta deliveries includes the CERES Delivery Memo (see Reference 16) and, if applicable, updated versions of the subsystem Test Plan (see Reference 14) and Operator's Manual (see Reference 17). Data Products Catalog pages (see Reference 2) for which the subsystem team is responsible are included with a Sample Read Package. No formal documentation is required for Coefficient deliveries.

CERES CM has developed a set of reference material to help subsystem personnel through the delivery process (see Reference 16).

2.4 CM Validation and Product Integration

CM Validation and Product Integration is broken into two tasks as shown in Figure 2-1: CM Testing (see Section 2.4.1) and Release to SIT (see Section 2.4.2). These tasks are performed by the CERES CM Team. The CM Testing process consists of compiling the software and executing the appropriate tests as specified in the subsystem Test Plan (see Reference 14) in the SSI&T area on *AMI-P*. When all tests are successful, the software is released to the ASDC SIT Team.

2.4.1 CM Testing

Once a Full Subsystem or PGE(s) specific delivery is made to CERES CM, the delivered files are moved to the SSI&T area in the ASDC production environment. The software is compiled using the procedures provided in the subsystem Test Plan. If compilation is not successful, the subsystem team is contacted for resolution.

When the software has been successfully compiled the appropriate tests as described in the subsystem Test Plan are run and the output is compared following the directions provided. Comparison software is generally provided with the delivery to assist in evaluating the results. If the data created are scientifically equivalent to the expected output data files included in the delivery as per the evaluation procedures in the subsystem Test Plan, the CERES CM validation is considered complete. The successful compilation of the software and execution of the test cases acts as an audit of the delivered files.

If a problem is discovered during testing, the subsystem team is notified. The subsystem team may need to take one of the following actions: correct the Test Plan, provide modified software or data files as an update to the existing delivery, or cancel the delivery. CERES CM testing is resumed in the first two cases when the appropriate update is received. More detailed information on the CERES CM testing and procedures can be found in the CERES CM Plan (see Appendix B).

2.4.2 Release to SIT

After the testing is completed, a release notification is sent to the ASDC SIT team to inform them that operational testing may begin.

2.5 CERES SDT Reviews

This section describes CERES SDT Peer Reviews and Annual Process Plan Reviews. Reviews are a very important part of the CERES software development process. As their scope does not easily fit into the more chronological context of this document, this section will describe CERES SDT reviews.

2.5.1 CERES SDT Peer Reviews

Peer reviews are performed on software and documents as deemed necessary by the DMT Lead or the Science Team based on the following criteria:

- Unexplained errors in data products
- Requested by the customer
- New CERES SDT documentation
- Updating CERES SDT documentation for the first time in 10 years

A peer review team may consist of members from both the CERES Science Team and the SDT. There may also be at least one independent reviewer. Team members should be knowledgeable of the subject matter. The author of the item being reviewed must be a member of the peer review team and will lead the review. A team recorder will be appointed to document the review.

The maximum time allotted for a peer review is one week. If more than a week is necessary to review a complete software package or document, they will be divided into smaller components that can be individually reviewed within a week.

The author will initiate the peer review by a formal email announcement that will identify the team, the location of the meeting, the time of the meeting, and the material that will be reviewed. Review material will also be provided.

Team members will bring information to the peer review on the amount of time spent preparing for the review and how many defects were found in the item being reviewed. The recorder will take minutes including preparation time of the various reviewers, the number of defects found by each reviewer, a list of the defects found, and the action items that result from the review including suggested responsibility for the action item. The minutes prepared by the peer review recorder are the official record of the peer review's proceedings.

An attendance list will also be collected. In addition, where appropriate, marked copies of the reviewed materials will be provided to the author.

The author will use the official minutes to prepare the action item list containing the action items, the responsible parties, and, ultimately, the resolution of the action items. The resolution to the action items may be conveyed by the responsible party to the author in the form of email or other formal documentation.

The minutes, action item list, and attendance list will be stored by the CERES PIC on a contractor's secure and backed-up computer system.

The Stakeholder-Commitment Sheet needs to be updated after the successful completion of a Peer Review.

2.5.2 Annual Process Plan Review

The CERES Production Software Development and Implementation Plan must be reviewed annually by at least one of the Primary Contributors as identified in the Stakeholder-Commitment Sheet for the plan. The purpose of this review is to ensure the plan, as written, still describes the processes that we follow and that any changes made are consistent throughout the plan. If a process has been improved and the plan has not yet been updated to reflect the improvement, it should be updated as a result of this review. Also, as part of the annual review, it should be determined if there has either been a change in the stakeholders for the plan or a change in the plan's content since the last annual review. If so, the Stakeholder-Commitment Sheet needs to be updated.

The PIC has the responsibility to ensure that annual process reviews are completed in keeping with this section.

2.5.3 Record Keeping

The Document Revision Record should document all review activity.

3.0 CERES Science Code Implementation Process

Following the release of a software delivery to the SIT Team (see Section 2.4.2) it becomes the responsibility of the ASDC under the oversight of the CERES DMT Lead to test the released software in the ASDC computer environment, promote the software delivery to the ASDC production environment, generate and archive specified data products, and distribute, on request, approved data products to the public and science communities.

3.1 Processing Requests

The primary mechanism for the CERES PI to specify CERES processing requirements to the ASDC is through CERES PRs. It is the responsibility of the CERES DMT Lead to approve each PR. These PRs specify the CERES products to be generated, the data range of the specified products, the instrument where the data stream was initiated, the PGE(s) necessary to process the data, the PGE's input requirements, and the naming convention for the output products. As multiple PGEs are frequently necessary to produce a single publicly available product, a series of individual PRs may be required to produce such CERES products. As the requirements for producing a data product may change between the times of PR generation and execution, PRs may need to be modified. All PRs are maintained electronically for the life of the CERES project. The following documents prepared and maintained by the PR Team and approved by the CERES DMT Lead describe the process, including tools and data, for preparing, maintaining, and utilizing PRs.

1. TBD Doc-1 (see Reference xxx)
2. TBD Doc-2 (see Reference xxx)
3. TBD Doc-3 (see Reference xxx)

3.2 ASDC – CERES Validiation and Verification

The ASDC Validation and Verification processes consist of testing in the appropriate production environment at the ASDC and of the final evaluation of the output data products by the subsystem and appropriate WG chair. These activities are broken into two tasks as shown in Figure 2-1: Operational Testing (see Section 3.2.1) and ValRx Testing (see Section 3.2.2). Operational testing is a part of the CERES validation process as it demonstrates that the product (CERES subsystem software) fulfills its intended use when placed in its intended environment. ValRx Testing is also a part of the validation process as it is during this testing that the software is first run in the operational production environment. In addition, ValRx Testing is also a part of the CERES verification process since more thorough test cases as specified by the Science Team can be run through the subsystem software in this operational production environment – cases that may still be required to thoroughly ensure that the subsystem software meets its specified requirements. Both the Science Team and SDT carefully review the ValRx results as this is the last opportunity to catch errors or inconsistencies with the requirements before operational processing commences.

3.2.1 Operational Testing

The ASDC SIT Team uses a suite of tests designed to ensure the software will perform correctly in the operational production environment for product validation purposes. The SIT Team also makes any necessary updates to the production scripts. Once all of the tests have successfully completed in the SSI&T area, the software is promoted into the operational production environment for ValRx Testing, if required. The SIT Team sends a Promotion Notification via

email to the CERES CM Team which indicates to the CM Team that the SCCR associated with this software delivery can be closed (see Section B-2.5). The following documents prepared, maintained, and approved by the ASDC management describe the processes followed by the ASDC in the performance of Operational Testing.

1. TBD Doc-1 (see Reference xxx)
2. TBD Doc-2 (see Reference xxx)
3. TBD Doc-3 (see Reference xxx)

Note to JG – One of these documents needs to contain the list of steps SIT follows.

3.2.2 ValRx Testing

The validation part of ValRx testing is performed in the operational production environment to ensure that updates made to the production scripts are accurate. Subsystems may test at the SCF with several days of input data which is approved by the Subsystem's WG chair. However, several days of data are not always adequate to determine the validity of the data products. The ValRx testing allows several months of data to be processed and verified before production processing begins. The amount of data used for ValRx testing is determined on a case-by-case basis by the subsystem's WG chair and the DMT Lead. The WG chair, or designated WG personnel, is responsible for analyzing the results of the verification programs (software developed by or for the Science Team to verify the results of the CERES software) and for preparing the Data Quality Summary which is available through the ASDC ordering tool (see Reference 15).

The subsystem's WG chair and the subsystem team review the results from the final validation/verification testing. The subsystem team generates any statistical tables or graphics requested by the WG chair. Should any algorithm errors be identified, the WG chair makes the decision whether or not to begin production processing. If the decision is not to begin operational production processing, then the algorithm errors are resolved, and the process is repeated as appropriate. The following documents prepared, maintained, and approved by the ASDC management describe the processes followed by the ASDC in the performance of ValRx Testing.

1. TBD Doc-1 (see Reference xxx)
2. TBD Doc-2 (see Reference xxx)
3. TBD Doc-3 (see Reference xxx)

3.3 Produce and Archive Data Products

Following the successful completion of the ASDC's testing of the delivered software it is the responsibility of the ASDC to produce CERES data products in the production environment according to approved PRs. It is also the ASDC's responsibility to manage these products as specified in the CERES File Management Policy (see Reference 18). **Note to JG – Can we add some words about the epilogue script?** The following documents prepared, maintained, and approved by the ASDC management describe the processes followed by the ASDC to produce, manage, and archive CERES data products.

1. TBD Doc-1 (see Reference xxx)
2. TBD Doc-2 (see Reference xxx)
3. TBD Doc-3 (see Reference xxx)

3.4 Announce and Release Public Products

A process has been developed by the CERES SDT to ensure that the data product content is verified and that all associated software and documentation are updated before a CERES data product is released to the public. This process includes tasks not only for the subsystem team, but also tasks to be completed by the subsystem's WG chair, the SIT Team, and the ASDC User Services group. The CERES DMT Lead is ultimately responsible for providing approval to the ASDC that a particular CERES data product may be released and for ensuring that records are maintained to document that the release was made according to process. The following documents prepared and maintained by XXXXX and approved by the CERES DMT Lead describe the processes followed to verify that a CERES data product is ready for release and to announce the public release of the product.

1. TBD Doc-1 (see Reference xxx)
2. TBD Doc-2 (see Reference xxx)
3. TBD Doc-3 (see Reference xxx)

4.0 Processing of Global Satellite Science Data (LMS-OP-1400)

LMS-OP-1400 (see Reference 19) is the Science Directorate's organizational procedure for the "Processing of Global Satellite Science Data" and must be compatible with all pertinent SD projects. During internal and external audits of the CERES software development processes this procedure is used as the high-level reference process for the audit, so, in effect, it is what the software development task is audited against. In this section there is a subsection for each step of LMS-OP-1400 shown for the DMT that describes how CERES complies with the procedure. Of course, the first step is to ensure that you have the current "1400".

4.1 Identify the available auxiliary data sources and the method of acquisition

The Interface Requirements Document (see Reference 20) captured all original interface requirements. Current information for ancillary data may be found in the subsystems' Operator's Manuals (see Reference 17) and in the CERES Data Products Catalog (see Reference 2).

Note that the input and output file information from the Operator's Manuals is consolidated into the File Management Policy as requested by the ASDC.

4.2 Prepare a draft Data Management Plan and distribute to the technical and data management teams

The CERES Data Management Plan (see Reference 21) was first prepared in June 1990. The applicable content from the initial Data Management Plan has been incorporated into this document.

4.3 Work with the technical team to transition the algorithms to an operational processing environment

CERES is a mature effort that has been around since the early nineties (the CERES Data Management Plan was first released in June 1990). Consequently, the initial set of algorithms was transitioned to the operational processing environment at the ASDC some time ago. Now, the process to release new and updated software to the ASDC is shown in Figure 2-1 and Table 2-2. The comments on the CERES Software Development Lifecycle are also related to this discussion (see Section 2.1.5).

4.4 Perform testing of the algorithms for accuracy and efficiency in conjunction with technical team

As shown in Figure 2-1 and Table 2-2, verification and validation testing is done throughout the CERES software development processes. See specifically Sections 2.3.1, 2.3.3, 2.3.4, 2.4.1, 3.2.1, and 3.2.2.

4.5 Compile the End-to-End Test Data Report (as applicable)

Our end-to-end tests are at the subsystem level, as CERES publicly available end products are produced as a result of subsystem-level processing. Each subsystem may address this requirement somewhat differently as may be addressed in the appropriate WG's validation plan. Artifacts that may be appropriate are the results from subsystem-level delivery testing (see Section 2.3.3), CM testing (see Section 2.4.1), and ValRx testing (see Section 3.2.2), as well as

standardized QC reports and data quality summaries. Also, TRLs document that CM testing was completed.

References

1. NPR 7150.2, Chapter 5, Software Documentation Requirements (http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=7150&s=2)
2. CERES Data Products Catalog (http://ceres.larc.nasa.gov/dpc_current.php)
3. CERES On-Line Documentation Website (http://ceres.larc.nasa.gov/docs.php)
4. CERES Brochure (http://ceres.larc.nasa.gov/ceres_brochure.php)
5. AMI Computer System at the ASDC (https://asdcstatus.larc.nasa.gov/systemstatus/)
6. CMMI Guidelines for Process Integration and Product Improvement, CMMI-DEV. Version 1.3, Mary Beth Chrissis et al., Addison-Klesley, March 2011.
7. Sampling Strategy, Production Strategy, and Configuration Code Implementation at the Langley TRMM and Terra Information System (LATIS) (http://ceres.larc.nasa.gov/documents/intern_docs/pdf/ss.ps.cc.pdf)
8. Cost Xpert – The Estimation Company (http://www.costxpert.com/)
9. CERES Software Requirements Documents (http://ceres.larc.nasa.gov/srd.php)
10. CERES Software Design Documents (http://ceres.larc.nasa.gov/sdd.php)
11. CERES Algorithm Theoretical Basis Documents (http://ceres.larc.nasa.gov/atbd.php)
12. CERES Software Coding Guidelines (http://ceres.larc.nasa.gov/documents/SCG/SCG_V2.pdf)
13. CERES Software Bulletins (http://ceres.larc.nasa.gov/sw_bull.php)
14. CERES Test Plans (http://ceres.larc.nasa.gov/test_plans.php)
15. ASDC Website (http://eosweb.larc.nasa.gov)
16. CERES CM System Home Page (http://earth-www.larc.nasa.gov/cerescm/)
17. CERES Operator's Manuals (http://ceres.larc.nasa.gov/ops_man.php)
18. CERES Data Management Team Internal Documents (http://ceres.larc.nasa.gov/Internal/intern_docs.php)
19. Science Directorate's "Processing of Global Satellite Science Data" (LMS-OP-1400) (https://lms.larc.nasa.gov/admin/documents/1400.pdf)
20. CERES Interface Requirements Document (http://ceres.larc.nasa.gov/documents/IRD2_doc.pdf)
21. CERES Data Management Plan (June 1990) (http://ceres.larc.nasa.gov/documents/DMP_Plans/pdfs/ceres_DMP.pdf)
22. CERES Requirements Logs (http://ceres.larc.nasa.gov/requirements_logs.php)
23. CERES Science Team Meetings (2004 to Present) (http://ceres.larc.nasa.gov/science-team-meetings2.php)
24. CERES Science Team Meetings (2000-2003) (http://ceres.larc.nasa.gov/science-team-meetings.php)
25. CERES Processing Oversight Board Meeting Minutes (http://ceres.larc.nasa.gov/cpob.php)

Appendices

Appendix A contains a list of acronyms used throughout this document. All acronyms used in this document are defined in this appendix. They are not defined in the text.

The CERES SDT developed and follows a set of customized processes for developing, testing, controlling, delivering, and maintaining the CERES production science software that is run operationally at the ASDC. The remainder of these appendices contains a description of each of these key processes as used in the development and implementation of the CERES production software as follows.

Appendix B – Configuration Management Plan
Appendix C – Document Management Plan
Appendix D – Measurement and Analysis Plan
Appendix E – Process and Product Quality Assurance Plan
Appendix F – Requirements Management Plan

The processes described in Appendix B through Appendix F were the basis of successful SCAMPI As in 2006, 2009, and 2012 under two technical support services contracts supporting this work.

Appendix A
Acronyms

AMI	ASDC Modernization through Integration
ASDC	Atmospheric Science Data Center
ATBD	Algorithm Theoretical Basis Document
CERES	Clouds and the Earth's Radiant Energy System
CERESlib	CERES library
CCB	Configuration Control Board
CDR	Climate Data Record
CI	Configuration Item
CM	Configuration Management
CMMI	Capability Maturity Model Integrated
COTS	Commercial Off-the-Shelf
CPOB	CERES Production Oversight Board
CPOBM	CERES Production Oversight Board Meeting
DC	Document Checklist
DFT	Delivered Files Tracking
DMS	Data Management System
DMT	Data Management Team
DocM	Document Management Plan
DP	Data Processing
DPC	Data Products Catalog
EOS	Earth Observing System
ERBE	Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
FM	Flight Model
FTP	File Transfer Protocol
GGEO	Gridded Geostationary Narrowband Radiances
LaRC	Langley Research Center
LMS	Langley Management System
MOA	Meteorological, Ozone, and Aerosols (data product)
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NPR	NASA Procedural Requirements

PDF	Portable Document Format
PGE	Product Generation Executive
PIC	Process Improvement Coordinator
PI	Principal Investigator
PR	Processing Request
QA	Quality Assurance
QStats	Quarterly Delivery Statistics Report
SARB	Surface and Atmospheric Radiation Budget
SCAMPI	Standard CMMI Appraisal Method for Process Improvement
SCCR	Software Configuration Change Request
SCF	Science Computing Facility
S'COOL	Students' Cloud Observations On-Line
SDP	Science Data Processing (Toolkit)
SDT	Software Development Team
SEC	System Engineering Committee
SGI	Silicon Graphics Incorporated
SIT	Software Integration and Testing
SNPP	Suomi National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project
SOW	Statement of Work
SS	Subsystem
SSI&T	Science Software Integration and Testing
SW	Shortwave
TISA	Time Interpolation and Space Averaging
TOA	Top of the Atmosphere
TOT	Total
TRL	Test Results Log
TRMM	Tropical Rain Measuring Mission
TSA	Time/Space Averaging
VIIRS	Visible Infrared Imager Radiometer Suite
WG	Working Group

Appendix B
Configuration Management Plan

B-1.0 CERES CM Plan

The CERES CM Plan discusses the process used to manage CERES CIs as defined in Section B-1.3.2. The CERES CM Team will provide a user-friendly system to assist users in implementing procedures to perform CM-related tasks such as preparing SCCRs and delivering software. The procedures explained in this document are based on the current experience of the CM Team. As new situations arise or the system is improved, these procedures will be modified accordingly.

B-1.1 CERES CM System

The CERES SDT is developing the production software to process data from the CERES instruments and produce science data products which will be archived as part of the EOS program. The job of the CERES CM system is to manage CERES computer files containing software, required data for CERES data processing, and documentation all associated with deliveries of the CERES software to the ASDC. These computer files that are under the control of the CERES CM system are referred to as CIs in this document. The management of CERES CIs includes receiving the delivery of CIs from the individual subsystems, moving CIs to the ASDC production environment, testing the CIs as appropriate according to the Test Plan provided by the subsystem, releasing CIs to the ASDC SIT Team, storing CIs, and controlling the configuration of the CERES production software by overseeing changes and ensuring that they are properly authorized and maintained. The CERES CM system is implemented on the SCF. In this document, CM Server refers to the *AMI* computer system at the ASDC which is part of the SCF.

The configuration control of other CERES documentation as listed in Table 2-1 is managed by the CERES Documentation Team.

B-1.2 CERES CM Organization

The CERES CM Team is a small group (typically three or less) of analysts who are members of the CERES SDT. The CM Team provides procedures for implementing and implements the CERES CM Plan.

The CERES CCB is comprised of all members of the SDT. The DMT Lead serves as the CCB Chairperson and, as such, leads a discussion during the biweekly CPOB meetings on all SCCRs that have been submitted or updated since the last meeting. CCB members that are in attendance at the CPOB meeting may provide comments, but it is the CCB chairperson that is the decision making authority concerning CERES CIs. See Section B-2.1.1 for more information on the SCCR approval process.

B-1.3 CM Definitions

B-1.3.1 Configuration Control

Configuration control for CERES is the systematic process of maintaining and tracking the life cycle of a CI. It includes the procedures that are established for requesting and submitting a change to a CI, and it allows for the retrieval of a CI at any time during its life cycle.

B-1.3.2 Configuration Identification

The name and version number of a particular CERES CI establishes a specific configuration identification for that CI. Each CERES CI has a unique filename or configuration identification. Table B-1-1 contains a list of CERES CIs and their associated configuration identification. In the table elements of the configuration identifications are defined. The Release Number, R#, defines which mission is associated with the CI, i.e., 1, pre-launch development; 2, TRMM; 3, Terra; 4, Aqua; 5, SNPP.

Table B-1-1. CI Tracking

CI	Configuration Identification
Requirements Log (Excel or PDF)	**SS**_req_log_**V##**.xls
Delivery Memo (Word or PDF)	**SS**_del_memo_**R#-SCCR**.(doc) or (pdf)
Test Plan (Word or PDF)	**SS**_test_plan_**R#V##-SCCR**.(doc) or (pdf)
Operator's Manual (Word or PDF)	**SS**_opman_**R#V##-SCCR**.(doc) or (pdf)
Compressed Ancillary Data Tar File	**SS**_anc_**R#-SCCR**.tar.(Z) or (gz)
Ancillary Data List File	**SS**_anc_**R#-SCCR**.list
Compressed Source Code Tar File	**SS**_src_**R#-SCCR**.tar.(Z) or (gz)
Source Code List File	**SS**_src_**R#-SCCR**.list
Compressed Other Data Tar File	**SS**_data_**R#-SCCR**.tar.(Z) or (gz)
Other Data List File	**SS**_data_**R#-SCCR**.list
Data Products Catalog section (Word or PDF)	DPC_**PROD**_**R#V#**.(doc) or (pdf)
Collection Guide (Word or PDF)	**PROD**_CG_**R#V#**.(doc) or (pdf)

Key

SS - instrument, erbelike, clouds, inversion, InstSARB, TISAgrid, TISAavg, SynSARB, ggeo, RegridMOA, CERESlib, Perl_Lib
R# - Release number (example, Release 5 is represented by R5)
V## - Version number (example, Version 2 is represented by V2)
PROD - BDS, ES8, ES9, ES4, SSF, CRS, FSW, SFC, ISCCP-D2like-Day/Nit, SYN, AVG, ZAVG, SRBAVG, ISCCP-D2like-GEO, INSTR, IES, EID-6, CRH, SYNI, GGEO, TSI, MOA, CID_VIRS, CID_MODIS, CID_VIIRS, SURFMAP, GEO, APD, GAP, MWH, OPD
SCCR - SCCR number

B-1.3.3 Baselines

A baseline is a configuration identification that is associated with a specific time in a CIs life cycle. CM maintains a baseline for each subsystem delivery. During CERES software development updates are made to the subsystems baselines. Following the updates the software version that successfully passes all subsystem, CM, and ASDC testing and has been promoted to the operational production environment becomes the starting baseline for the next delivery. This baseline is stored in the CM repository.

B-1.4 CERES CM Responsibilities

It is the responsibility of the CERES CM Team to design and implement a CM system that provides the level of configuration management that is appropriate for the CERES project. The CERES CM System provides procedures for accepting, moving, testing, releasing, storing, and controlling CERES CIs and their updates. These procedures are described in Section B-2.1 through Section B-2.6 of this document.

The CERES CM Team is responsible for establishing baselines for the CERES CIs and maintaining updates to these baselines (see Section B-2.6). Configuration control and configuration identification is also the responsibility of the CERES CM Team.

B-1.5 CERES CM Audits

During CM Testing the successful compilation of the software and execution of the test cases from the subsystem Test Plan acts as a configuration audit of the delivered files to demonstrate that the integrity of the configuration baseline is being maintained.

B-2.0 CERES CM Process

The CERES CM Team manages CIs for each of the CERES subsystems listed in Table B-2-1 that fall under the domain of the CERES CM System.

Table B-2-1. CERES Subsystems

Subsystem Number	Subsystem Name
1.0	Instrument
2.0 & 3.0	ERBE-like
4.1 - 4.4	Clouds
4.5 & 4.6	Inversion
5.0	Instantaneous SARB
6.0 & 9.0	TISA Gridding
7.1, 7.3, 8.0, & 10.0	TISA Averaging
7.2	Synoptic SARB
11.0	GGEO
12.0	MOA
CERESlib	CERES Library
Perl_Lib	Perl Library

There are procedures in place to ensure that each CI managed by the CERES CM System is properly introduced into the system, relocated as required to the Langley ASDC and to the appropriate CM storage location, and that updates to the CIs are controlled and records of these updates maintained. More specifically, there are six currently supported CM functions.

1. Receive CI from Subsystem
2. Move CI to the ASDC
3. Test CI in the production environment
4. Release CI to the ASDC
5. Store CI in CM storage repository
6. Control and maintain records of updates to CI

The CM procedures used to perform the six CM functions are described below in Section B-2.1 through Section B-2.6.

The CERES subsystem delivery schedule is available on the Web through the CM Dashboard. Section B-4.0 contains more information on schedules.

In addition to these scheduled deliveries, there will, of course, be unscheduled deliveries that must be made to correct or update CIs that have previously been delivered. These unscheduled deliveries are made when circumstances dictate.

The scheduled deliveries are somewhat more systematic. Over a three-week period the activities listed in Table B-2-2 take place.

Table B-2-2. Activities Prior to the Software Release to the ASDC

Schedule	Activity
1 week before the Release to the ASDC	The subsystem emails the Test Plan and/or Operator's Manual associated with this delivery if updates were necessary to the Documentation Team. The subsystem delivers the *Delivery Memo* and the *Delivery Package* containing the CIs to CM.
The week of the Release to the ASDC	The finalized *Test Plan* is delivered by Documentation to CM. Using the finalized Test Plan, CM compiles and tests the delivered software. CM releases the *Delivery Package* and associated documentation to the ASDC SIT Team.

B-2.1 Receive CI from Subsystem

This is the first of the six functions performed by the CM Team that make up the CERES CM process as discussed in the previous section. This function is composed of the following three steps;

- SCCRs must be submitted prior to a software delivery. Section B-2.1.1 describes the submission through approval process for SCCRs.
- CIs are actually received as a result of the subsystem teams using the CMmove script as described in Section B-2.1.2.

Subsystem personnel should follow the CERES Subsystem Delivery Procedures (see Section B-5.1) which describes in more detail all of the steps in this section.

B-2.1.1 SCCR

Regarding SCCRs, these are the steps that must be taken prior to a CI being received by CERES CM for delivery to the ASDC. See the CERES CM SCCR Help Page (http://earth-www.larc.nasa.gov/cgi-bin/cgiwrap/cerescm/mysql/cerescm.pl?page=sccr_help) for more information on completing an SCCR.
The DMT Lead serves as the CCB Chairperson and is the approval authority for SCCRs. The DMT Lead has authorized the CM Team Lead or a specified back up to designate the SCCR as approved or disapproved using the CERES CM on-line tool.

1. An SCCR is completed and submitted using the on-line SCCR form (http://earth-www.larc.nasa.gov/cgi-bin/cgiwrap/cerescm/mysql/cerescm.pl?option=create). An email is automatically sent by the CERES CM on-line tool to the CERES CM Team, the ASDC

SIT Team, the SDT, and appropriate Science Team members, notifying them that an SCCR has been submitted and listing the contents of the SCCR in the email for their review.

2. The CERES CM Team presents the SCCR to the CCB for approval. If the SCCR is disapproved, the CI change process terminates, and the SCCR is designated as disapproved. An email stating that the SCCR has been disapproved is automatically sent by the CERES CM on-line tool to the CERES CM Team, the ASDC SIT Team, and the SDT.
3. If the SCCR is approved, the SCCR is designated as approved, an email announcing the approval is automatically sent by the CERES CM on-line tool to the CERES CM Team, the SDT, and the ASDC SIT Team, and the changes requested on the SCCR can be made to the appropriate CIs by the appropriate software developer. This email sent by the on-line tool serves as the official CERES communication that the SCCR has been approved by the CCB Chairperson.

See Figure B-2-1 for more information on the SCCR process.

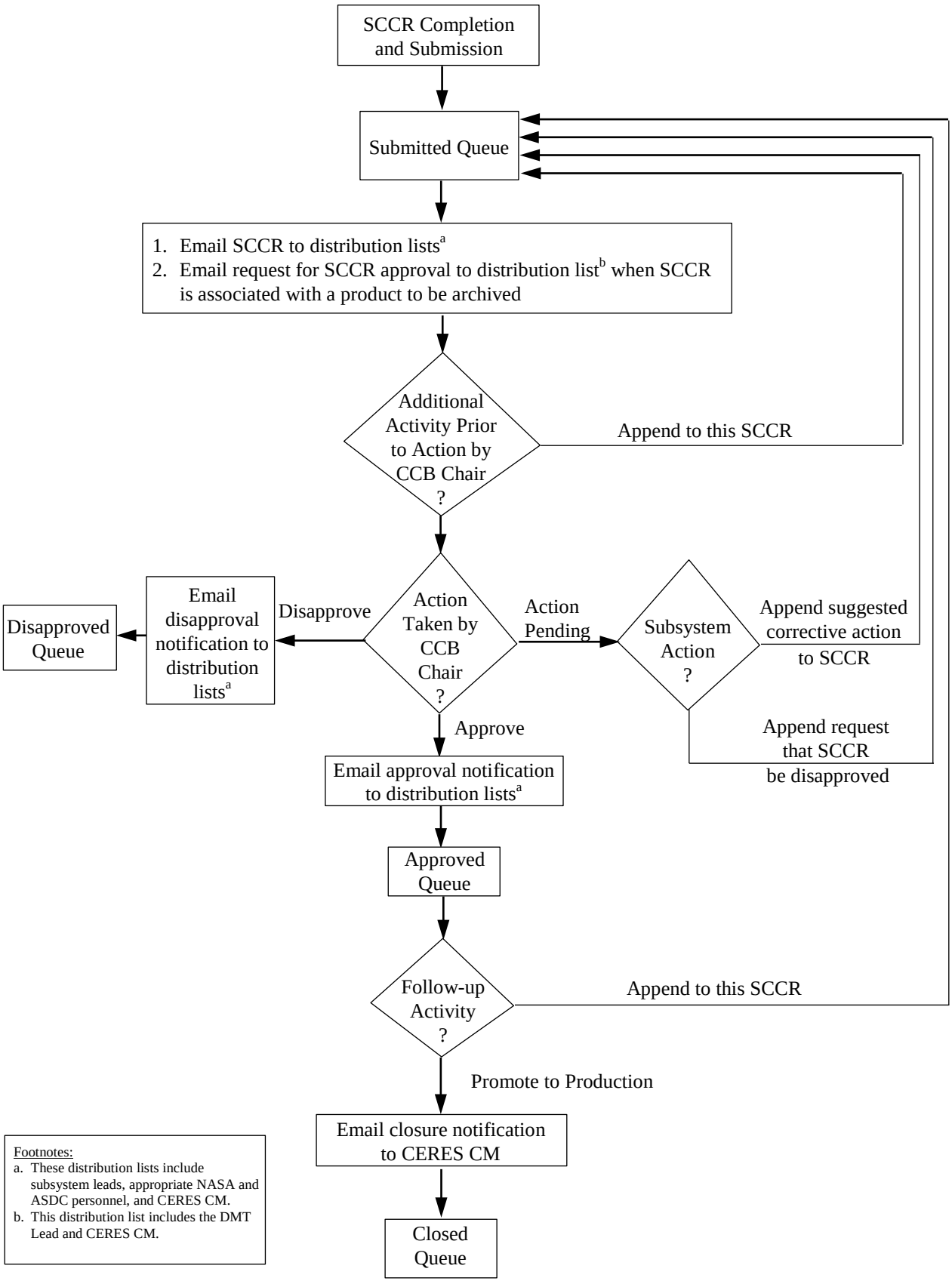

Figure B-2-1. SCCR Process

B-2.1.2 Moving CIs into the CERES CM system (CMmove)

The next step is to move the CIs contained in a delivery package into the CERES CM system. An understanding of the CERES CM directory structure will be useful in following the movement of the subsystem CIs once they are entered into the CERES CM system. Figure B-2-2 shows the CERES CM directory structure on the CM Server.

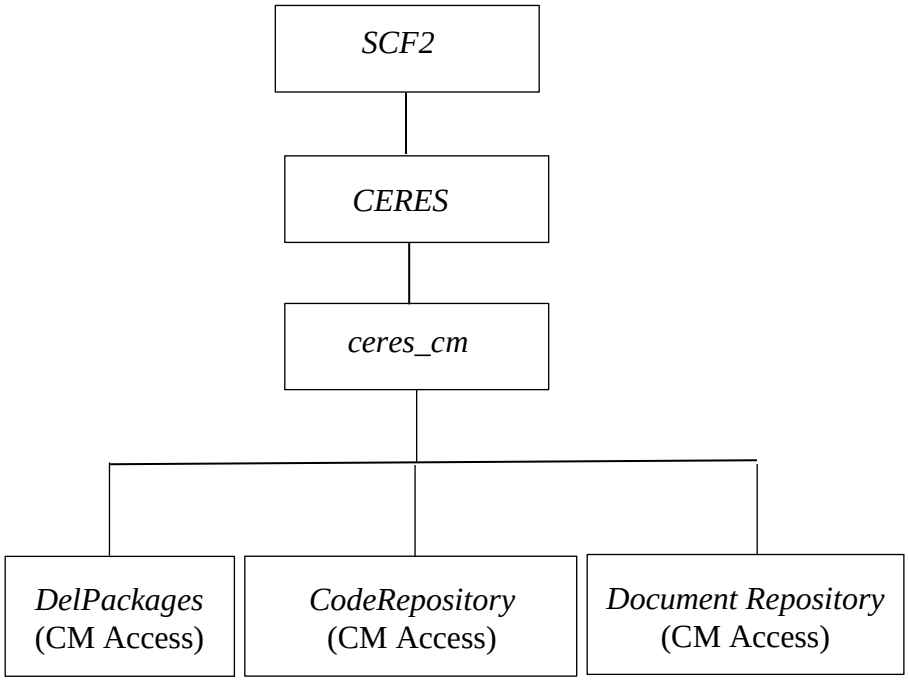

Figure B-2-2. CM Directory Structure on the CM Server

The five categories of deliveries a subsystem can make to CERES CM are described in Table B-2-3.

Table B-2-3. Delivery Categories

Delivery Category	Description of Delivery Package	Required Documentation
Full Subsystem	Includes all PGEs with associated source, scripts, ancillary, input, and expected output data files that comprise the complete subsystem delivery.	Delivery Memo and, if applicable, updated Test Plan and Operator's Manual.
PGE(s) Specific	Includes all files necessary for the PGE(s) being delivered.	Delivery Memo and, if applicable, updated Test Plan and Operator's Manual.
Delta	Includes only scripts and/or data files.	Delivery Memo and, if applicable, updated Test Plan and Operator's Manual.
Coefficient	Includes instrument gain, spectral response function, GGEO coefficient, or other types of files that need to be periodically delivered.	No formal documentation required.
Sample Read Package	Includes any updates necessary to support reading an output data product whose format was changed.	DPC pages for which the subsystem team is responsible.

The Sample Read Package is provided to the ASDC User Services and is distributed to a user when a CERES data product is ordered from the ASDC. Guidelines on the content to be included in the Sample Read Package are defined by the ASDC User Services.

The CMmove script was prepared by CERES CM for subsystem teams to use to deliver CIs (source code, ancillary data, and other data) to CM. These CIs are included in tar files by the subsystem teams as detailed in the CERES Subsystem Delivery Procedures (see Section B-5.1) prior to invoking the CMmove script. As a result of the subsystem team invoking the CMmove script, these CIs are stored in the DelPackages directory as described in Figure B-2-2 and an email is automatically sent to the CM Team notifying them that the CMmove has been performed. Once in the DelPackages directory, the script also changes the file permissions and ownership so that only members of the CM Team have write permission.

If the subsystem Test Plan and/or Operator's Manual were updated for a delivery, those CIs are delivered to the CERES Documentation Team (larc-ceresdoc@lists.nasa.gov) as Word file attachments in an email from the subsystem team. After the Documentation Team ensures that the documents conform to CERES standards the files are stored permanently in the document repository.

The subsystem team creates the Delivery Memo and sends it to CM (larc-cerescm@lists.nasa.gov) as an email attachment. These files are stored on individual workstations that are routinely backed up and are only accessible to the CERES CM Team.

B-2.2 Move CI to the ASDC

Once the delivered tar files are in the DelPackages directory on the CM Server, the CM Team moves the CIs to the /SPG_ops/delivery/CERES/incoming directory in the ASDC production

environment. The associated subsystem documentation (Test Plan, Operator's Manual) is posted on the Web after the files have been reviewed and standardized by the Documentation Team. The SIT Team is notified via email that the document is available online.

B-2.3 Test CI

The CM Team compiles and tests the delivered software according to the instructions in the subsystem Test Plan. This ensures that all of the necessary files for this baseline were delivered and that the testing results created in the ASDC production environment are scientifically equivalent to what the subsystem team produced at the SCF. As a delta delivery is comprised of only scripts and/or data files, the CM Team only tests a delta delivery if the subsystem team requests it. The operational testing performed on a delta delivery by the ASDC SIT Team will ensure that the proper files were delivered. The steps followed by the CM Team to perform this function are detailed in the CM Testing Procedures (see Section B-5.2). If the CM Team encounters any problems compiling or testing the delivered software, the subsystem team is notified. The subsystem team may need to take one of the following actions: correct the Test Plan, provide modified software or data files as an update to the existing delivery, or cancel the delivery. The CM Team also tracks the defects discovered during CM testing along with the causes of these defects and records the occurrence of defects in TRLs. TRLs are stored by the CERES CM Team on individual, regularly backed-up workstations. CERES CM testing is resumed in the first two cases when the appropriate update is received.

B-2.4 Release CI to the ASDC

After successfully testing the delivered software, it is released to the ASDC for operational testing. The CM Team sends a Release Notification email, including the Delivery Memo as an attachment, to the ASDC SIT Team. An example Release Notification can be found in the CM Testing Procedures (see Section B-5.2).

B-2.5 Move CI to CM storage repository

After the delivered software is promoted to the operational production environment, the ASDC SIT Team sends a Promotion Notification email to the CM Team and appropriate subsystem team. Based on this email, the CM Team closes the SCCR associated with the delivery, creates the final tar files, and stores them in the appropriate subsystem subdirectory in the CodeRepository directory on the CM Server. Once this is done, the original tar files are deleted from the DelPackages directory.

B-2.6 Control and maintain records of updates to CI

Baselines for each release of CERES CIs are established after the CM Team stores the CIs in the appropriate directory on the CM Server as described in the previous section. The approved SCCR for this software delivery is the fundamental record for this baseline. Should further updates to the baseline be required, the appropriate subsystem submits a new SCCR documenting the software modifications, and the process begins again.

B-3.0 CERES CM System Home Page - Information Resources and Tools

The CERES Configuration Management System Home Page is located at http://earth-www.larc.nasa.gov/cgi-bin/cerescm/mysql/cerescm.pl. On this page are lists of CM related information and software tools. Tools available for managing SCCRs are found along the top of the Web page. These tools are,

- Create SCCR
- View SCCR
- Modify SCCR
- User Registration
- CM Admin – This area is accessible only to members of the CM Team. The tools to approve, disapprove, update, and close an SCCR are found here.

The main section of the **CERES Configuration Management System** contains the following information.

General Information

- CM Plan (PDF)
- Lessons Learned
- PGE Sizes for *magneto*
- PGE Sizes for *AMI*
- SEC Presentation (PDF)
- Documentation Guidelines

Delivery Information

- CM Schedules
- Subsystem Delivery Procedures (PDF)
- CM Naming Conventions
- CERESlib Change Procedures

Documentation

- Delivery Memos
- Delivery Memo Template
- Operator's Manual Template
- Test Plans
- Test Plan Guidelines (PDF)
- Test Plan Template

Delivery Promotion Information

- Promoted Directories Document (PDF)

Contacts

- CM Team
- Documentation Team

B-4.0 Delivery Schedules

The CERES DMT Lead meets periodically with the CERES PI to develop data processing priorities for CERES data to be run at the ASDC. In addition, data from SCCRs are used to populate the CERES Subsystem Delivery Schedule as well as the SCCR Dashboard Database from which the Open SCCR Table is generated; this table is a key support document used during the CPOB meetings to track the progress of software deliveries. The schedule contains information regarding the various deliveries such as subsystem making a delivery, when the delivery is due to CERES CM, when the delivery is to be released by CERES CM to the ASDC, whether there is an associated CERESlib or Perl_Lib delivery needed, whether there are new PGEs associated with the delivery, and what the certified platforms are for the delivery.

This schedule information as shown in the previous section can be found on the CERES Dashboard reports page.

B-5.0 Technical Notes

B-5.1 CERES Subsystem Delivery Procedures

1. Review CERES Subsystem Delivery Schedule on the CERES Dashboard Reports page (dashboard-ceres.larc.nasa.gov/reports.php). The schedule is created on the fly from the information stored in the dashboard database when "Generate Delivery Schedule" is selected.

2. An SCCR should be submitted when you expect or are planning to make changes to your subsystem's software configuration.

3. Test Plans and Operator's Manuals only need to be delivered if they have been updated since the last time they were delivered. If changes need to be made to these documents, download the Word file for the document from the Web. Go to the CERES On-Line Documentation page (http://ceres.larc.nasa.gov/docs.php) and select the type of document that needs to be updated. Then select the appropriate document from the specific document Web page.

   Note:
   Before you make any changes to your document make sure Track Changes is turned on. You must also select Track Changes from the Options menu and set Insertions to Underline and Deletions to Strikethrough. All of these must be set each time in each document before you make any modifications in order for the final version of your document to have the changes documented.

4. Ensure that the correct output file names are included in and are consistent between the Test Plan and Operator's Manual and that these names accurately reflect the names of the output files that are created by the software.

5. Test Plan Instructions
   - When the code is tested prior to delivery, be sure to use the Test Plan that you intend to send to CERES CM. Once you've completed testing do not change the Test Plan.
   - Be sure that the execution time stated in the Test Plan for each test is accurate as tested on the target platform.
   - Be sure to include the output file names for the test case(s) either in the Test Plan or in a file included in the delivery package. If the file names are listed in a file, make sure the file is referred to by name in the Test Plan in the appropriate place (i.e., after the output files are created).
   - Instructions for how and when to execute the clean-up script(s) should be in the Test Plan.
   - List the names of executables created by the compilation instructions.

6. Send Word versions of the Test Plan and Operator's Manual as e-mail attachments to larc-ceresdoc@lists.nasa.gov. See Table B-5-1 for information on how the files should be named. If formatting assistance is needed for either the Test Plan or Operator's Manual, please send the document with instructions to larc-ceresdoc@lists.nasa.gov or talk to one of the members of the CERES Documentation Team.

7. Send the Operator's Manual as soon as possible (at least a week or two before delivering to CERES CM). This will shorten operational testing time since the ASDC uses information from the Operator's Manual to write and update scripts used during testing. If information in the Operator's Manual is inaccurate, the testing time will increase.

8. Clean-up script(s) for test cases which remove the files created by executing the Test Plan commands should be included in the delivery package.

9. Clean-up script(s) which remove files created during production runs should be included in the delivery package and information on the use of these scripts should be in the Operator's Manual.

10. Print exit codes to the screen.

11. Don't deliver object code or executables.

12. Don't deliver the smf.log file.

13. Test and create expected output on the target platform. Get an account on the target platform if you don't already have one.

14. Don't deliver input data for your test cases in other subsystem directories. Include the files somewhere in your subsystem directory structure (e.g., the input directory) and include instructions in the Test Plan for copying (not moving) these files to the appropriate directory (i.e., the directory where the subsystem generating the input data as output data puts the files).

15. Tar File Instructions
    - In general, there will be 3 tar files provided with each Full or PGE delivery: source, ancillary data, and all other data (see Table B-5-1).
    - Tar files should be created by the subsystem from the **working group level** (/SCF2/CERES/sarb/testing/**sarb/...**) and should include all of the directories from the directory structure established by the Langley ASDC whether or not they contain any files.
    - Remove extraneous files/directories before creating tar files.
    - A list file will be generated upon successful delivery to the CM system. The list file contains a list of the contents of the tar file delivered.
    - Use the "gzip" command or the UNIX "compress" command to compress the tar files.

16. Make the subsystem delivery on or before the scheduled "Delivery to CERES CM" date according to the CERES Subsystem Delivery Schedule. If you can't do this, notify the CM Team (larc-cerescm@lists.nasa.gov) as soon as possible.

17. Deliver tar files to CERES CM by using the CMmove script found in /SCF2/CERES/ceres_cm/cm_bin on *AMI*. For example, /SCF2/CERES/ceres_cm/cm_bin/CMmove <tar_file_name.tar.Z>

1. Send the Word version of the Delivery Memo to larc-cerescm@lists.nasa.gov (see Table B-5-1). All sections should be completed except D.3.a.2, D.3.b.2, D.3.c.2, and D.3.d.2.

Table B-5-1. File Naming Conventions

File	File Name
Delivery Memo (Word)	**SS**_del_memo_**R#-SCCR**.doc
Delivery Memo (PDF)	**SS**_del_memo_**R#-SCCR**.pdf
Test Plan (Word)	**SS**_test_plan_**R#V##-SCCR**.doc
Operator's Manual (Word)	**SS**_opman_**R#V##-SCCR**.doc
Test Plan (PDF)	**SS**_test_plan_**R#V##-SCCR**.pdf
Operator's Manual (PDF)	**SS**_opman_**R#V##-SCCR**.pdf
Compressed Ancillary Data Tar File	**SS**_anc_**R#-SCCR**.tar.(Z) or (gz)
Ancillary Data List File	**SS**_anc_**R#-SCCR**.list
Compressed Source Code Tar File	**SS**_src_**R#-SCCR**.tar.(Z) or (gz)
Source Code List File	**SS**_src_**R#-SCCR**.list
Compressed Other Data Tar File	**SS**_data_**R#-SCCR**.tar.(Z) or (gz)
Other Data List File	**SS**_data_**R#-SCCR**.list
Requirements Log (Excel)	**SS**_req_log_**V##**.xls

Key
SS - instrument, erbelike, clouds, inversion, InstSARB, TISAgrid, TISAavg, SynSARB, ggeo, RegridMOA, CERESlib, Perl_Lib
R# - Release number (example, Release 5 is represented by R5)
V## - Version number (example, Version 2 is represented by V2)
SCCR - SCCR number

B-5.2 CM Testing Procedures

(In the examples, the Clouds Subsystem with SCCR # 421 is being used.)

Code delivered by the Subsystems is placed on *AMI* in /SCF2/CERES/ceres_cm/DelPackages by the CMmove script.

Log onto the target platform and set up the CERES environment based on the compiler listed in the Subsystem's Test Plan. The environment is set up by sourcing the CERES environment script in the home directory.

Note: Be sure that umask and group are set correctly. The command "umask 002" can either be added to your .cshrc file or typed on the command line.

Copy or FTP the files from *AMI* to /SPG_ops/delivery/CERES/incoming on *AMI-P*. Verify that the files were copied correctly by checking the file sizes on the two computers. No error is given if there was a problem with the FTP process.

Before uncompressing and untarring the files, vi the .list files and look through them for any files that obviously shouldn't have been delivered. Search specifically for .tar, .exe, and .o files. TISA Averaging is allowed to have .exe files in their Web directory. If there are files that shouldn't have been delivered, check with the Subsystem personnel and then delete the files from the .list file and also from the directory after untarring the tar file. If a lot of incorrect files are delivered then ask the Subsystem to correct the tar file and redeliver it.

On *AMI-P* copy the tar files to /SPG_ops/verify/CERES, and uncompress and untar them there.

Change directories to the $CERESHOME directory for SSI&T:

- cd /SPG_ops/SSIT/CERES

or

- cd $CERESHOME

If the delivery is a full subsystem delivery then the files from the previous delivery need to be removed from the SSI&T directory. For example,

- rm -rf /SPG_ops/SSIT/CERES/clouds (except /SPG_ops/SSIT/CERES/sarb)

If the delivery is a PGE delivery or a delta delivery then the files from the previous delivery are not removed.

Recursively copy the directory that was created when the files were untarred from /SPG_ops/verify/CERES to /SPG_ops/SSIT/CERES:

- cp -R /SPG_ops/verify/CERES/clouds .

Follow the subsystem's Test Plan to verify that the code works properly on the target platform. If no new Test Plan was delivered, download the latest version from the CERES Test Plan Web page (http://ceres.larc.nasa.gov/test_plans.php); otherwise, use the delivered Test Plan. Look for any environment variables that are set differently from the standard variables. If the delivery is

not a full subsystem delivery only compile and test the delivered PGEs. If the delivery is a delta delivery then the Subsystem decides if it's worth running the Test Plan.

When testing is complete, check the Delivery Memo for correctness. To fill in Sections D.3.a.2, D.3.b.2, D.3.c.2, or D.3.c.4, go to /SPG_ops/SSIT/CERES/lib/p6-xlf/bin and run local_version.csh. Create a PDF version of the Delivery Memo.

Send email to the SIT Team (larc-asdc-cereststst@lists.nasa.gov) to release the delivery to the ASDC and cc the CM Team (larc-cerescm@lists.nasa.gov), the DMT Lead, the CERES Supervisor, the appropriate subsystem personnel, and the PR Team (ceres-production-coordination-list@lists.nasa.gov) with subject of "Clouds Release Notification (SCCR nnn)."

Release Notification email example:

==========
CERES CM Release Notification
==========

Clouds (Subsystems 4.1-4.4) is now available on *AMI-P* for SGE and operational testing. Attached is a PDF version of the Clouds Delivery Memo. This delivery is in reference to SCCR #421.

The following files were delivered to /SPG_ops/delivery/CERES/incoming:

clouds_anc_R3-421.list
clouds_anc_R3-421.tar.Z
clouds_data_R3-421.list
clouds_data_R3-421.tar.Z
clouds_opman_R3V10-421.pdf
clouds_src_R3-421.list
clouds_src_R3-421.tar.Z
clouds_test_plan_R3V10-421.pdf

The delivered tar files were copied to /SPG_ops/verify/CERES and un-tarred. The /SPG_ops/verify/CERES/clouds directory which was the result of the un-tarring was recursively copied to /SPG_ops/SSIT/CERES. In /SPG_ops/SSIT/CERES/clouds, the code was successfully compiled and tested according to the subsystem's Test Plan.

Thanks,
Tammy

Note that if the delivery was a delta delivery for which no testing was done, then change the last line of the above email to "No testing was done for this delta delivery."

Also note that for CERESlib and Perl_Lib deliveries the first sentence of the Release Notification is changed to "CERESlib is now available on *AMI-P*" since no operational testing is done.

If a new version of the Subsystem's Test Plan and/or Operator's Manual was delivered, then the Documentation Team notifies the SIT Team of its availability after the final version of the document is posted on the appropriate Web page.

Test Plan Delivery email example:

The updated Clouds Test Plan is available on the Test Plans Web page (http://ceres.larc.nasa.gov/test_plans.php). This document is in reference to SCCR #421.

Thanks,
Joanne

Operator's Manual Delivery email example:

The updated Clouds Operator's Manual is available on the Operator's Manual Web page (http://ceres.larc.nasa.gov/ops_man.php). This document is in reference to SCCR #421.

Thanks,
Joanne

Remove the files associated with the just released delivery from /SPG_ops/verify/CERES.

Close the appropriate SCCR after receiving notification that the delivery was promoted to production.

Instrument Gains Files Delivery email example (send to larc-asdc-cereststst@lists.nasa.gov, cc larc-cerescm@lists.nasa.gov, the DMT Lead, the Instrument Subsystem Lead, and the CERES Supervisor):

==========
CERES CM Delivery Notification
==========

The updated gains for Terra FM1 and FM2 for the period beginning March 1, 2002 through December 31, 2002 and for Aqua FM3 and FM4 for the period beginning January 1, 2003 through April 30, 2003 are now available on *AMI-P*.

The following files were delivered to /SPG_ops/delivery/CERES/incoming:

instrument_gains_20030219.list
instrument_gains_20030219.tar.Z

The delivered tar file was copied to /SPG_ops/verify/CERES and un-tarred. The /SPG_ops/verify/CERES/instrument directory which was the result of the un-tarring was recursively copied to /SPG_ops/SSIT/CERES.

Once the files have been promoted to production, CER1.3P3 can be processed for Terra for data from March 2002 through September 2002. NOTE: The Aqua gains are not expected to change, which is why they have been extended through April 2003. Since Denise will be out of town most of April, this will allow production of Aqua Edition1/Beta2 products to continue for Instrument. However, there may be changes in the Spectral Response Functions, so ERBE-Like should not be run for March and April 2003 before checking with Ed Kizer to determine if he will have any updates.

Thanks,
Tammy

3. ERBE-like Spectral Response Function Files Delivery email example (send to larc-asdc-ceresstst@lists.nasa.gov, cc larc-cerescm@lists.nasa.gov, the DMT Lead, the ERBE-like Subsystem Lead, and the CERES Supervisor):

==========
CERES CM Delivery Notification
==========

The updated Spectral Response Function files for Terra FM1 and FM2 for the period beginning October 1, 2001 through February 28, 2002 are now available on *AMI-P*. The following files were delivered to /SPG_ops/delivery/CERES/incoming:

erbelike_srf_Terra_20030129.list
erbelike_srf_Terra_20030129.tar.Z

The delivered tar file was copied to /SPG_ops/verify/CERES and un-tarred. The /SPG_ops/verify/CERES/erbelike directory which was the result of the un-tarring was recursively copied to /SPG_ops/SSIT/CERES.

Once the files have been promoted to production, CER2.4P1 can be processed for Terra FM1 and FM2 for the dates shown above.

NOTE: Only run CER2.4P1 for the 15th of the month.

CER2.4P1 should be run with FM1 SW and TOT channel srf changes only.
Where xxx = 12
Example: gen_pcf.CER2.4P1 20011015 12
CER2.4P1 should be run with FM2 TOT channel srf changes only.

Where xxx = 2
Example: gen_pcf.CER2.4P1 20011015 12
CER2.2P1, CER2.3P1, and CER2.3P2 should then be
run with the following options: A F M T
Where snow = A, adm = F, spcor = M, and swoff = T
Example: gen_pcf.CER2.2 20011012 A F M T

Thanks,
Tammy

Appendix C
Document Management Plan

C-1.0 CERES Document Management Plan

The CERES DocM Plan discusses the overall plan for the documentation management of the CERES documents as defined in Section C-1.2. The procedures explained in this document are based on the current experience of the CERES DocMT. The CERES DocMT is responsible for the distribution, archival, maintenance, formatting, posting and maintaining the Websites, and version control of these documents and reports. As new situations arise or the system is improved, these procedures will be modified accordingly.

C-1.1 CERES DocM Organization

The CERES DocMT is composed of personnel from SSAI who support the CERES project.

The CERES DocMT is a small group of SSAI employees who are members of the CERES DMT. The DocMT provides procedures for implementing the CERES DocM Plan.

C-1.2 DocM Definitions

C-1.2.1 Documentation Control

Documentation control for CERES is the systematic process of maintaining and tracking the life cycle of a document. It includes the procedures that are established for any necessary modifications.

C-1.2.2 Documentation Identification

The name and release and/or version number of a particular CERES document establishes a specific documentation identification. Each CERES document corresponds to a file naming convention. Table C-1-1 contains a list of CERES file naming conventions and their associated documentation identification. In the table elements of the documentation, identifications are defined. The Release Number, R#, defines which mission is associated with the document (where applicable); i.e., 1 - pre-launch development; 2 - TRMM; 3 - Terra; 4 - Aqua, 5 – SNPP-5.

Table C-1-1. File Naming Conventions

File	File Name
Delivery Memo (Word)	**SS**_del_memo_**R#**-SCCR
Test Plan (FrameMaker)	**SS**_test_plan.book **SS**_test_plan.cover **SS**_test_plan.revision **SS**_test_plan.preface **SS**_test_planTOC.doc **SS**_test_planLOF.doc **SS**_test_planLOT.doc **SS**_test_plan.doc **SS**_test_plan.app**?**
Operator's Manual (FrameMaker)	**SS**_opman.book **SS**_opman.cover **SS**_opman.revision **SS**_opman.preface **SS**_opmanTOC.doc **SS**_opmanLOF.doc **SS**_opmanLOT.doc **SS**_opman.doc **SS**_opman.app**?**
Test Plan Compressed Tar File	**SS**_test_plan_**R#V##**-SCCR.tar.Z
Test Plan (PDF)	**SS**_test_plan_**R#V##**-SCCR.pdf
Operator's Manual Compressed Tar File	**SS**_opman_**R#V##**-SCCR.tar.Z
Operator's Manual (PDF)	**SS**_opman_**R#V##**-SCCR.pdf
Compressed Ancillary Data Tar File	**SS**_anc_**R#**-SCCR.tar.Z
Ancillary Data List File	**SS**_anc_**R#**-SCCR.list
Compressed Source Code Tar File	**SS**_src_**R#**-SCCR.tar.Z
Source Code List File	**SS**_src_**R#**-SCCR.list
Compressed Other Data Tar File	**SS**_data_**R#**-SCCR.tar.Z
Other Data List File	**SS**_data_**R#**-SCCR.list
Requirements Log (Excel)	**SS**_req_log_**V##**.xls

Key

SS - instrument, erbelike, clouds, inversion, InstSARB, TISAgrid, TISAavg, SynSARB, ggeo, RegridMOA, CERESlib

R# - Release number (example, Release 3 is represented by R3)

V## - Version number (example, Version 2 is represented by V2)

? - Letter of the particular appendix (example, Appendix A is represented by appA)

C-1.3 CERES DocMT Responsibilities

It is the responsibility of the CERES DocMT to design and implement a DocM Plan that provides the level of documentation management that is appropriate for the CERES project. The CERES DocMT is responsible for and provides procedures for formatting, version control, archival, maintenance, posting, and distribution of these documents and reports.

These procedures are described in Section C-2.1 through Section C-2.1.6 of this document.

Documentation control and documentation identification are also the responsibility of the CERES DocMT.

C-2.0 CERES Documentation Management Process

The CERES DocMT manages documentation for each of the following CERES subsystems.

Subsystem Number	Subsystem Name
1.0	Instrument
2.0 & 3.0	ERBE-like
4.1 - 4.4	Clouds
4.5 & 4.6	Inversion
5.0	Instantaneous SARB
6.0 & 9.0	TISA Gridding
7.1, 8.0, & 10.0	TISA Averaging
7.2	Synoptic SARB
11.0	GGEO
12.0	MOA
CERESlib	CERES Library
Perl_Lib	

Note: The above lists the primary documentation controlled and maintained by the DocMT. There are other documentation controlled and maintained by the DocMT that do not fall under the above Subsystem categories.

There are procedures in place to ensure that each document managed by the CERES DocMT is properly introduced into the system, delivered as required to the Langley ASDC and to the appropriate DocM storage location, and that updates to the documents are controlled and records of these updates maintained. More specifically, there are seven currently supported DocM functions.

1. Receive document from Subsystem Lead
2. Copy document to appropriate working directory
3. Follow applicable document procedures
4. Post document on Website
5. Send out e-mail notifications detailing the delivery and the Website pertaining to the document
6. Fill out the DC - see Section C-11.0 (this applies only to the Test Plans and Operator's Manuals)
7. Archive files

The D&DP used to help implement the seven DocM functions are described below in Section C-2.1 through Section C-2.1.6.

The following processes normally average a couple of days (or less) to complete.

On the scheduled date of document delivery	The Subsystem Lead sends the necessary documentation by way of a Word document file through e-mail. The DocMT copies the file into a working directory on their computer and follows the D&DP.
On completion of the document modifications	After the operator's manual documentation has been modified, etc., pdf files are created. The Word and pdf files are then posted to the document's corresponding Website and notifications are sent through email that they are completed. The test plans documentation are modified and initially delivered to the one who is testing the plan to make sure the code works. After it has been verified that the test plan works, then the pdf file is created and the Word and pdf files are posted to the document's corresponding Website and notifications are sent through email that they are completed. The Documentation Checklists are also filled out on each document.. Archive document files.

The D&DP used to perform the seven DocM functions are described below in Section C-2.1 through Section C-2.1.6.

C-2.1 Receive Document from Subsystem Team

This is the first of the seven functions performed by the DocMT that make up the CERES DocM process as discussed in the previous section. This function is composed of the following three steps;

- The Test Plan and/or Operator's Manual is delivered to the CERES DocMT (larc-ceresdoc@lists.nasa.gov) as a Word file attachment in an e-mail from the subsystem team. Other types of documentation (other than Test Plans and Operator's Manuals) will also be sent via e-mail. The Test Plans and Operator's Manuals are being used as examples as they are the majority of documentation received.
- The Operator's Manual should be sent as soon as possible (at least a week before delivering to CERES CM). This will shorten operational testing time since the ASDC uses information from the Operator's Manual to write and update scripts used during testing. This will also allow the File Management Policy to be updated as soon as possible with the Operator's Manual changes.
- Make the documentation delivery on or before the scheduled "Delivery to CERES CM" date according to the latest CERES Subsystem Delivery Schedule (http://dashboard-ceres.larc.nasa.gov/). If you can not do this, send e-mail to larc-cerescm@lists.nasa.gov as soon as possible.

The complete CERES D&DP are located in Section C-10.0 and describe in detail all of the steps in this section and the following.

C-2.1.1 Copy Document to Appropriate Working Directory

After receiving the Word file attachment from the subsystem team, it is then copied into the appropriate working directory on the DocMT's computer. The DocMT proceeds to rename the file and create a "changebar" copy so verification can be made that all of the changes in the document are in the Revision Record - as this copy has the "track change" option on after receiving it from the System Lead and will show all changes made in the document.

C-2.1.2 Follow Applicable Document Procedures

The DocMT now proceeds to follow the guidelines listed in the CERES D&DP (see Section C-10.0). A sample of the procedures include the following:

- Normal formatting is checked throughout the document. Normal formatting includes extra spaces between sentences, paragraphs, using the spell-checker, and just the general looks of the document.
- The cross-references are checked to make sure that they are hyperlinked to the proper sources and highlighted in blue.
- The headers are checked on each page to make sure the Version and Release number are correct, the date is current, and the document title is correct; and the footers are checked to make the sure the page numbers are correct and the Appendices begin with the usual A-1, B-1, C-1, etc.

- The document revision page is checked to make sure it is filled in accurately.
- The Table of Contents, List of Figures, and List of Tables are regenerated in every document.
- When modifications are complete, the file name is checked to make sure it follows the guidelines for the proper file naming convention and a pdf file is created. (See File Naming Conventions in Table C-1-1.)
- The pdf and Word files are posted to the appropriate Website. It is the Word file that the authors pull from the Web when they begin to make new changes. The Subsystem Lead turns on the "track change options" and it will indicate any new changes that are made to the document.

Note: If the DocMT encounters any problems with the document, the subsystem team is notified. The subsystem team may need to take one of the following actions: send a new Word document, provide a modified document to replace the existing one, or through proper e-mail channels send the modifications that need to be addressed in the document.

C-2.1.3 Post Document on Website

After the document has been modified, the pdf and Word documents are posted to the appropriate Website.

C-2.1.4 Send Out E-mail Detailing the Delivery and/or the Website Pertaining to the Document

After the pdf and Word documents have been created and the documentation posted to the appropriate Website, an e-mail is sent to the appropriate recipients. Please see Section C-7.0 for proper e-mail notifications for various documents.

C-2.1.5 DC

After modification of the Operator's Manual and/or Test Plans have been accomplished, fill out the DC (see Section C-11.0). This checklist confirms that all of the procedures were followed and executed. The DC does not need to be filled out for other documentation (or updated Operator's Manuals and Test Plans).

C-2.1.6 Archive Document Files

The Word documents and pdf files are archived on the DocMT's computer in the appropriate named directories for quick retrieval, if necessary. Final files are archived to *AMI*.

C-3.0 CERES On-Line Documentation Home Page and CERES CM Home Page

Located on the CERES On-Line Documentation Website (http://ceres.larc.nasa.gov/docs.php) are the following documentation and Websites that are periodically or routinely updated by the DocMT.

C-4.0 Applicable Documentation

- Data Management Plan
- Data Products Catalog
- Software Coding Guidelines
- Collection Guides
- Operator's Manuals
- Requirements Logs
- Test Plans
- DMT to DAAC Production Requests
- Data Management Team Internal Documents (File Management Policy)
- Data Management Team Status Reports

Located on the CERES CM Website (http://earth-www.larc.nasa.gov/cgi-bin/cerescm/mysql/cerescm.pl) are the following documentation and Websites that are periodically or routinely updated by the DocMT.

C-5.0 General Information (Documents)

- Configuration Management Plan
- SEC Presentation - CERES Delivery & Test Process
- Documentation Guidelines

C-6.0 Delivery Information (Documents)

- Subsystem Delivery Procedures
- Naming Conventions
- Documentation
- Delivery Memos
- Delivery Memo Sample
- Delivery Memo Template
- Test Plans (this site can also be accessed by going to http://ceres.larc.nasa.gov/docs.php)
- Test Plan Guidelines
- Test Plan Sample

Note: The above documentation in Section C-3.0 was created as Excel, Microsoft Word, or .php files. They are posted in either .php, pdf, or Microsoft Word formats.

C-7.0 E-mail Notification Process

C-7.1 Delivery Memo Release Notification

The Delivery Memo is sent as an attachment to the Release Notification E-Mail. The Release Notification is discussed in the Configuration Management Plan (see Appendix B). This e-mail also contains any other tar files and documents that need to be delivered to the ASDC after the code has been tested.

C-8.0 Tools and Software Applications

Tools and software applications that are used to create, modify, maintain, and control documentation encountered by the CERES DocMT include (but are not limited to) the following:

2. Excel - spreadsheet software application
3. Microsoft Word - word processing software application
4. .php - scripting language for Web development
5. PowerPoint - a viewgraph/slide software application
6. emacs - a display editor used to view and modify ascii files
4. Ipswitch – a tool to transfer files back and forth from home and remote computers
5. Putty – a terminal software

C-9.0 Technical Notes

C-10.0 Documentation Procedures

Listed below are the Documentation Procedures starting with receiving the document from the author (Word file), up until the time the document is posted on the Web page:

1. The Test Plan or Operator's Manual is sent by the author as an e-mail attachment to larc-ceresdoc@lists.nasa.gov.
2. The Operator's Manual should be sent as soon as possible (at least a week or two before delivering to CERES CM). This will shorten operational testing time since the ASDC uses information from the Operator's Manual to write and update scripts used during testing. This will also allow the File Management Policy to be updated as soon as possible with the Operator's Manual changes.
3. Make the documentation delivery on or before the scheduled "Delivery to CERES CM" date according to the latest CERES Subsystem Delivery Schedule (http://dashboard-ceres.larc.nasa.gov). If you can not do this, send e-mail to larc-cerescm@lists.nasa.gov as soon as possible.
4. Once the document is received, copy the document into a working directory. Rename it so you can keep a copy of it with the tracking changes so you can make sure all changes were noted in the Revision Record.

5. Normal formatting is checked throughout the document. Normal formatting includes extra spaces between sentences, paragraphs, using the spell-checker, and just the general looks of the document. Also, check for the correct font sizes and font styles in the tables and make sure no "orphan" lines are left on a page.
6. The cross-references are checked to make sure that they are hyperlinked to the proper sources and highlighted in blue. Sometimes these are highlighted in blue but have not been linked, or highlighted at all. (Note: Many authors cut and paste. It is easy to cut and paste and even easier to forget to change the numbers pertaining to that section that it is cut and pasted into.)
7. The headers are checked on each page to make sure the Version and Release numbers are correct, the date is current, and the document title is correct.
8. The footers are checked to make the sure the page numbers are correct and the Appendices begin with the usual A-1, B-1, C-1, etc.
9. The document revision page is checked to make sure it is filled in accurately.
10. The Table of Contents, List of Figures, and List of Tables are regenerated in every document. Because of formatting and other modifications, these need to be regenerated each time because a section could shift from one page to another.
11. When everything appears correct, accept all changes and save and rename with the correct file name (see File Naming Conventions – Table C-1-1). This will be the copy that will be posted on the Web (and you keep the changebar copy in case you need to go back and see what was changed with the tracking changes option).
12. A pdf file is also created.
13. The pdf and Word files are then posted on the Website on *ceres.larc.nasa.gov* in their proper directories and the .php file is corrected to indicate the correct date, release number, version number, and file names. The links on the Web page are then checked to make sure they are bringing up the proper documents.
14. When the Test Plan documents are posted, an e-mail is sent to larc-cerescm@lists.nasa.gov (Tammy Ayers, John Robbins, Dennis Keyes, and Joanne Saunders - SSAI), Gleason, Jonathan L. (LARC-E302) <jonathan.l.gleason@nasa.gov> (Jonathan L. Gleason - NASA), and the author(s) of the document.
15. When the Operator's Manual documents are posted, an e-mail is sent to larc-cerescm@lists.nasa.gov (Tammy Ayers, John Robbins, Dennis Keyes, and Joanne Saunders - SSAI), Gleason, Jonathan L. (LARC-E302) <jonathan.l.gleason@nasa.gov> (Jonathan L. Gleason - NASA), and to the author(s) of the document.
16. When the Collection Guide documents are posted, an e-mail is sent to the larc-ceresdoc@lists.nasa.gov and the System Leads.
17. Also, the pdf and Word copies of the Test Plans and Operator's Manuals are archived to the Document Repository on *AMI* which is /SCF2/CERES/ceres_cm/DocumentRepository.

C-11.0 Documentation Checklist

Name of Document:
(Release and Version No.)

_____

Author: _____

SCCR No.: _____

Date Received: _____

Date Completed: _____

The steps listed below are followed after the document (tarfile) is received from the author and up until the document is posted on the Web page:

Item No.	Item	Completed
1	The document is received by e-mail from the author (in a Microsoft Word file that has been downloaded from the appropriate Website). The filename is checked to make sure it follows the guidelines for the proper naming convention and has the correct release and version number.	
2	The document is placed in a working directory.	
3	A copy is saved with ".changebar" at the end of the filename to distinguish the copy with the changes turned on and a copy that will be the final copy cleared later of the tracking changes. The "track changes" in the document are checked against the Revision Record to ensure that all changes are recorded accurately.	
4	Normal formatting is checked throughout the document. This includes extra spaces between sentences, paragraphs, using the spell-checker, and just the general looks of the document. Also checking for the correct font sizes and font styles in the tables and making sure no "orphan" lines are left on a page.	
5	The cross-references are checked to make sure that they are linked to their appropriate sources and highlighted in a blue font color. (For example: a lot of the authors cut and paste. It is easy to cut and paste and even easier to forget to change the numbers pertaining to the appropriate section and to highlight the link in blue.)	
6	The headers are checked on each page to make sure the Release and Version number are correct, the date is current, and the document name is correct.	
7	The footers are also checked to make sure the page numbers are correct and the Appendices begin with the usual A, B, C, etc.	
8	The Table of Contents, List of Figures, and List of Tables are regenerated in every document. Because of formatting and other modifications, these need to be regenerated each time because a section could shift from one page to another.	
9	The pdf and word files are then posted on the Website on *wbs128* in their proper directories and the .php file is corrected to indicate the correct date, release number, version number, and filename. The links on the Web page are then checked to make sure that they are bringing up the proper document.	

Item No.	Item	Completed
10	**The word file that now resides on the appropriate Website is the one that will be downloaded by the author the next time modifications need to be made.**	
11	**When the Test Plan and/or Operator's Manual documents are posted, an e-mail is sent to larc-cerescm@lists.nasa.gov (Tammy Ayers and Joanne Saunders - SSAI), Jonathan.L.Gleason@nasa.gov (Jonathan L. Gleason - NASA) or Christopher.J.Harris@nasa.gov (Chris Harris – NASA), Elizabeth.C.Heckert@nasa.gov (Elizabeth Heckert – SSAI), Edward.A.Kizer@nasa.gov (Ed Kizer – SSAI), Lisa.H.Coleman@nasa.gov (Lisa Coleman – SSAI), Walter.F.Miller@nasa.gov (Walt Miller – SSAI), and the author(s) of the document. This email indicates that the document has been posted to the appropriate Website.**	
12	**When the Test Plan and/or Operator's Manual documents are posted, an e-mail is also sent to larc-asdc-cereststt@lists.nasa.gov (ASDC - SSAI), larc-cerescm@lists.nasa.gov (Tammy Ayers and Joanne Saunders - SSAI), Jonathan.L.Gleason@nasa.gov (Jonathan L. Gleason - NASA) or Christopher.J.Harris@nasa.gov (Chris Harris – NASA), Lisa.H.Coleman@nasa.gov (Lisa Coleman – SSAI), and Walter.F.Miller@nasa.gov (Walt Miller – SSAI). This email indicates that the document has been posted to the appropriate Website and is available for the ASDC.**	
13	**The pdf and word files of the Test Plan and Operator's Manual are archived to *AMI* (*ceres-blue*), and drobo. The directories on *AMI* are as follows: /SCF2/CERES/ceres_cm/DocumentRepository/OperatorsManuals /SCF2/CERES/ceres_cm/DocumentRepository/TestPlans**	

Appendix D
Measurement and Analysis Plan

D-1.0 CERES Measurement and Analysis Plan

D-1.1 Measurement and Analysis Plan Objectives

The two main objectives of the CERES SDT are to deliver scientific source code to execute in the production processing environment maintained by the ASDC (1) on time according to a delivery schedule and (2) defect free. Relevant data are routinely collected, analyzed, and maintained to identify obstacles that may prevent the team from meeting these objectives. Data regarding the amount of actual time a delivery spends in SSI&T are also maintained to aid in setting schedules as accurately as possible. The purpose of the CERES DMS Measurement and Analysis Plan is to identify the data that are collected, and to describe the collection, maintenance, and analysis procedures of these data.

This Measurement and Analysis Plan is based on the current processes followed by the CERES project's SDT. Additional documents associated with the project provide the specific details regarding the data interfaces, processing algorithms, output products, instrument design and calibration, and science investigations as they are developed through the project lifecycle. These documents are accessible from the CERES On-Line Documentation Website (see Reference 3).

D-1.2 Measurement and Analysis Plan Organization

This appendix is organized as follows:

Section D-1.0 - CERES Measurement and Analysis Plan
Section 0 - Measurement Specifics
Section D-3.0 - Measurement Collection and Storage
Section D-4.0 - Analysis Procedures
Section D-5.0 - Summary
Section D-6.0 - Technical Notes

Section 0 describes the data that are routinely collected in order to identify weaknesses that may prevent meeting the major objectives of the CERES SDT. Section D-3.0 describes the process for collecting and maintaining these data. Section D-4.0 describes the report contents for the quarterly analysis of the data identified in Section 0, along with the responsibility, storage, and communication of the report.
Section D-5.0 contains a table summarizing the metric collection and analysis requirements described in this plan.

A list of abbreviations and acronyms is contained in Appendix A, and a sample of the quarterly report described in Section D-4.0 is included in Section D-6.1.

D-2.0 Measurement Specifics

SSI&T is comprised of multiple phases. The first phase, the CM testing phase, includes the delivery of production software to the CM Team through the CMmove utility, the placing of the files under configuration management, the generation of the executables, and CM testing of the software in the production environment. The first phase is complete when the CM Team releases the delivery by notifying the ASDC SIT Team that CM testing of the delivered software was successful and therefore the ASDC SIT Team testing phase may begin. SSI&T is complete when the SIT Team finishes operational testing (see Section 3.2.1). Additional testing beyond SSI&T occurs in the ASDC operational environment prior to full-scale production processing of software intended to generate science products available for public use. This additional testing typically processes data for selected dates from the full dataset intended for the production environment, providing results from a broad set of data-imposed scenarios and is complete when both the CERES Science Team and the SDT indicate approval of the results.

The CERES Measurement and Analysis Plan is applicable only to the CM testing phase of SSI&T, which includes the activities described in Section 2.4.1.

D-2.1 Adherence to Delivery Schedule

As stated in Section D-1.1, a main objective of the CERES SDT is to deliver scientific software to execute in the production processing environment maintained by the ASDC on time according to the CERES Subsystem Delivery Schedule. This delivery schedule lists the scheduled dates of software deliveries as agreed upon by the SDT and the CERES Science Team. The CERES CM Team tracks the scheduled delivery dates, the actual dates of deliveries to CM, and the dates the CM Team releases the deliveries to the ASDC SIT Team in the Delivered Files Tracking document. Tracking these dates provides data useful in monitoring how well the SDT is meeting the objective of delivering software to CM in accordance with the delivery schedule. The length of a delay is measured in calendar days.

Typically, the date scheduled for CM to release a delivery to the ASDC is seven calendar days after the date scheduled for that delivery to CM. This seven-day period allows time for CM activities and testing of the newly delivered software in its intended environment. Since a delivery made later than six days after the scheduled date eliminates the possibility that the CM Team can test, perform CM activities, and release the new delivery to the ASDC according to the Delivery schedule, a software delivery is considered delayed when six calendar days have passed since the scheduled delivery date to CM without the delivery occurring.

Since a delay in the release of the software to the ASDC results in a delay of completing SSI&T, and therefore a delay in the onset of production processing, the release of the delivery from the CM Team to the ASDC SIT Team is considered delayed when six calendar days have passed since the scheduled release date without the release occurring.

The reasons for delays may also be maintained for a period of time if deemed necessary by the management of the SDT. The reasons for delays to CM may include:

- Change in requirement definition by customer
- Subsystem/data dependencies not in place, e.g., missing external input data or previous subsystem has not delivered yet
- Incorrect estimation of time needed to implement requirements
- Lack of resources, either computer or personnel, for implementing requirements
- Imposition of other higher priority activity

The reasons for delays for the CM Team's release of the delivery to the ASDC SIT Team may include:

- Defects detected during CM testing
- Lack of resources, either computer or personnel, for testing, storage, etc.
- Imposition of other higher priority activity
- Late delivery of software to CM

D-2.2 Defect Data

As stated in Section D-1.1, another main objective of the CERES SDT is to deliver scientific source code that is free of defects to execute in the production processing environment maintained by the ASDC. The occurrence of a defect in the software prevents the successful completion of testing by the CM Team and may also result in a delay of the release of the software to the ASDC SIT Team (see Section D-2.1).

The CM Team tracks the defects discovered during CM testing along with the causes of these defects and records the occurrence of defects in the TRL. A defect is counted whenever an error occurs that results in corrections made by the SDT to data, software, or documentation files during CM testing. Tracking the defects provides data useful in monitoring problems encountered during CM testing that result in delays of software releases to the ASDC. The review of these data as discussed in Section D-4.0 may identify problems that need to be resolved to prevent recurrence.

The type of defects encountered during initial CM testing may also be maintained in the TRL if deemed necessary by the SDT management. The types of defects may include:

- Defects in delivery package assembly
- Defects in Test Plan
- Missing input data
- Incorrect expected output

D-3.0 Measurement Collection and Storage

The CERES CM Team is responsible for collecting, compiling, and storing the data regarding adherence to the delivery schedule and the number of defects.

Adherence to the most recent delivery schedule is documented in the Delivered Files Tracking document. Data regarding defects identified during CM testing are maintained in the TRL. Designated members of the CM Team enter the data into these reports with each delivery. These documents are stored by the CERES CM Team on individual, regularly backed-up workstations.

D-4.0 Analysis Procedures

Quarterly reports are generated from the data contained in the TRL and Delivered Files Tracking document. These reports show the scheduled and actual dates of software deliveries to CM and releases of software to the ASDC, along with the number of defects identified during CM testing. This information is stored in the QStats Report.

D-4.1 QStats Report Contents

The QStats Report consists of two sections. The first section contains information obtained from the TRL and Delivered Files Tracking document reports for the current quarter. At a minimum, the information contained in this section includes the following items for each delivery made during the quarter:

- Scheduled delivery date
- Delta between scheduled and actual delivery dates to CM
- Scheduled release date
- Delta between scheduled and actual release dates from CM to ASDC
- Number of defects identified during CM testing

The second section of the QStats Report contains a summary indicating whether or not the delivery delays and number of defects for the quarter are acceptable and if the cause for each is understood. If not, the comment section indicates the appropriate action to be taken to improve results in future quarters.

An example of the QStats Report is included in Section D-6.1.

D-4.2 QStats Report Responsibility

The initiation of the generation of the QStats Report and the completion of the first section are the responsibility of the CM Team. The CERES DMT Lead or his/her designee is responsible for reviewing the quarterly reports as received from the CM Team and completing the second section.

A QStats Report is completed within 15 calendar days after the end of each calendar quarter, with the beginning of the first calendar quarter for each year being defined as January 1.

D-4.3 QStats Report Storage

The completed QStats Report is provided back to the CM Team by the DMT Lead and is stored by the DMT Lead and CM Team on individual, regularly backed-up workstations.

D-4.4 Communication of QStats Report Results

The results contained in the QStats Report are communicated by the CERES DMT Lead to the CERES PIC. If the summary indicates corrective action by a particular subsystem team is necessary, the CERES PIC provides the pertinent summary information to that team. Table 2-1 identifies all of the SDT members whose tasks may be impacted by the contents of the QStats Report.

D-5.0 Summary

A summary of the data routinely collected, analyzed, and maintained during CM testing is contained in Table D-5-1.

Table D-5-1. Metric Collection and Analysis Requirements

	Schedule Variance: Delivery from Subsystem Team to CM Team	**Schedule Variance: Release from CM Team to ASDC SIT Team**	**Defects**
Measurement	Actual delivery date	Actual release date	Number of defects
Deviation	Delta = Actual delivery date - Scheduled delivery date	Delta = Actual release date - Scheduled release date	NA
Threshold	≤ 6 calendar days past scheduled date	≤ 6 calendar days past scheduled date	0
Acceptability Standard	Delta - Threshold ≤ 0	Delta - Threshold ≤ 0	Number of defects = 0
Frequency	Per Delivery	Per Delivery	Per Delivery
Owner	CM	CM	CM
Data Type: Report	Itemized List: DFT	Itemized List: DFT	Itemized List: TRL
Data Source	CM	CM	CM
Data Collector: Procedure	CM: Enter scheduled and actual dates into DFT	CM: Enter scheduled and actual dates into DFT	CM: Enter occurrence of defects into TRL
Storage	Individual, backed-up workstations assigned to CM Team	Individual, backed-up workstations assigned to CM Team	Individual, backed-up workstations assigned to CM Team
Analysis and Actions Taken	Delivery already late. Evaluate problem/identify preventative corrective action for future deliveries.	Release already late. Evaluate problem/identify preventative corrective action for future releases.	Corrective action taken for all defects found

D-6.0 Technical Notes

D-6.1 QStats Report Sample

Table D-6-1. Sample QStats Report

QStats Report for April 1, 2006 - June 30, 2006

Section I: CM Results

Report Date: July 7, 2006

Acceptable Delivery to CM Date Delta = 6 days | **Acceptable Release to ASDC Date Delta = 6 days**

Delivery Number	SCCR Number	Subsystem	Scheduled Delivery to CM Date	Actual Delivery to CM Date	Delta	Delta Minus Acceptable Delta	Scheduled Release to ASDC Date	Actual Release to ASDC Date	Delta	Delta Minus Acceptable Delta	Number of Defects	Action Required	Action Completed
1	621	Instrument	04/14/2006	04/14/2006	0.00	-6.00	04/21/2006	04/19/2006	-2.00	-8.00	0	None	N/A
2	618	GGEO	04/28/2006	04/20/2006	-8.00	-14.00	05/05/2006	04/24/2006	-11.00	-17.00	0	None	N/A
3	624	TISA Averaging	05/19/2006	05/19/2006	0.00	-6.00	05/26/2006	05/24/2006	-2.00	-8.00	0	None	N/A
4	626	Instantaneous SARB	05/26/2006	05/25/2006	-1.00	-7.00	06/02/2006	06/05/2006	3.00	-3.00	4	None	N/A
5	629	TISA Averaging	06/21/2006	06/20/2006	-1.00	-7.00	06/28/2006	06/21/2006	-7.00	-13.00	0	None	N/A

Section II: Supervisory Comments

Report Date: 13-Jul-06

Schedule Adherence: All deliveries to CM were either on time or early.

All deliveries were released to ASDC within the allowable time

Defects: 4 defects were noted for delivery Number 4. These defects were due to managing the massive quantities of input data that had to be staged on both the SGI and the IBM platforms. These problems were resolved and testing completed successfully with no corrections required to either the software or Test Plan that were delivered to CM.

Appendix E
Process and Product Quality Assurance Plan

E-1.0 CERES Process and Product Quality Assurance Plan

The purpose of the CERES Process and Product Quality Assurance Plan is to describe how compliance with the processes defined in this document is assured.

This document is organized as follows:

Section E-2.0 - Scope
Section E-3.0 - CERES Audits
Section E-4.0 - CERES QA Procedures
Section E-5.0 - Reports
Section E-6.0 - Templates

The Process and Product Quality Assurance Plan provides the SDT with objective insight into CERES processes and associated work products. The CERES PIC will be responsible for implementing this plan. This appendix provides a description of how the processes contained in the CERES Production Software Development and Implementation Plan will be audited using standard checklists. A template for each audit can be found in Section E-6.1 through Section E-6.7.

Documentation, either paper or electronic media, will be audited as a primary means of demonstrating adherence to standard processes. CERES documentation that is required as part of the software delivery will also be audited using standard checklists before being delivered to the ASDC. The results of these audits will be formally documented and maintained on the CERES PIC workstation which is backed up. The CERES PIC will prepare a status report as described in Section E-5.4 and provide it to the CERES DMT Lead and to contract management. A record of noncompliance issues and recommended corrective actions will be included in this report under key findings. Lessons learned from process and product audits will be used in improving the CERES processes.

E-2.0 Scope

The responsibility of QA resides with the CERES PIC. Key subsystem, system, and quality processes in the preparation and delivery of production software and related documentation will be audited.

E-2.1 Responsibility

The CERES PIC will assign personnel to perform the process and product audits defined in this appendix. The CERES PIC will coordinate with the assigned personnel to schedule audits, and will also collect checklists, and prepare the required reports.

E-2.2 Process Audits

Key processes have been chosen within the CERES Subsystem and System level that require auditing.

E-2.2.1 Subsystem-Level Processes

The following Subsystem-level processes will be audited:

- Requirements Management
- Production Software Development

E-2.2.2 System-Level Processes

The following System-level processes will be audited:

- Configuration Management
- Measurement and Analysis
- Project Management

E-2.3 Product Audits

The following CERES documentation products will be audited:

- Test Plan
- Operator's Manual

E-2.4 Quality Process Audits

The Process and Product Quality Assurance process will be audited.

E-3.0 CERES Audits

Audit periods are six-month periods beginning in January and July. During the second half of each period the PIC will identify process audits to be completed. Each subsystem will be audited on a subsystem-level process during each period. Each subsystem-level process will be audited during each period. The audit plan (see Section E-5.1) will be prepared by the PIC who will coordinate with the auditee and the auditor. The audit plan will be reviewed and updated as necessary by the PIC. The documentation team will audit the documentation products identified in Section E-2.3.

E-3.1 Process Audits

E-3.1.1 Subsystem Level

At the subsystem level two objectives will be accomplished:

1. Each subsystem-level process listed in Section E-2.2.1 will be audited during each six-month period.
2. Each subsystem will be audited during each six-month period.

However, if a subsystem-level process has not been used by the audited subsystem since its last audit, the Comments field at the bottom of the audit checklist will indicate that, and the audit for that process for that subsystem need not be completed.

E-3.1.2 System Level

The system-level processes listed in Section E-2.2.2 will be audited during each six-month period. However, if a system-level process has not been used since the last audit, the Comments field at the bottom of the audit checklist will indicate that, and the audit for that process for that subsystem need not be completed.

E-3.2 Product Audit

The CERES documentation products listed in Section E-2.3 will be audited by the CERES Documentation Team shortly after they are received for the first time with each unique SCCR. The audit will be completed before the documents are provided to the ASDC.

E-3.3 Quality Process Audit Schedule

A Quality Process audit (see Section E-2.4) will be performed every three years by someone outside of the CERES task. This audit will be arranged by the PIC.

E-4.0 CERES QA Procedures

Audits will be conducted using audit checklists. The auditor will check for objective evidence that the process was followed. Any best practices or lessons learned identified during the audit will be included in the comments section of the checklist. Best practices are methods that make a process more efficient or improve the product. Lessons learned are experiences, both positive and negative, that would benefit other SDT members.

E-4.1 Process QA Procedures – Subsystem Level, System Level, and Quality Process

The auditor will conduct a face-to-face interview with a representative of the team or the individual performing the process. The checklist for each process will be completed by the auditor using objective evidence provided during the interview.

The auditor will make note of any deviation from the standard process that cannot be corrected during the interview. The appropriate audit checklist and copies of objective evidence will serve to document the audit.

E-4.2 Product QA Procedures

The CERES Documentation Team will receive the document electronically. The documents will be reviewed for spelling, grammar, and formatting errors using the documentation checklist. The CERES Documentation Team will correct spelling, grammar, or formatting errors. The document originator will be contacted if more information is needed or the document may be returned to them for corrections.

Each CERES Documentation Team member who audited documents identified in Section E-2.3 will forward the associated Documentation Checklists to the CERES PIC by the last working day of each semiannual audit period.

E-5.0 Reports

The CERES Audit Plan, Audit Checklists, the CERES PPQA Action Item Tracking Log, and the QA Status Report are documents that are used in the QA process.

E-5.1 CERES Audit Plan

The CERES Audit Plan will identify the team and process being audited, the auditee, the auditor, and date of audit, as appropriate. This document (see Section E-6.1) will be reviewed by the PIC and action taken or updates made as necessary.

E-5.2 Audit Checklist

Audit checklists have been developed for each process and product identified in Section E-2.2 and Section E-2.3. A template for each audit checklist can be found in Section E-6.2 through Section E-6.8. These checklists will be maintained on the CERES PIC's workstation.

During each audit, a checklist will be completed. The audit checklist will identify

- the auditor and personnel interviewed during the audit,
- the date of the audit,
- the process or product audited, and
- any discrepancies found.

All checklists used during the audit will be reviewed by the CERES PIC who will approve or suggest additional corrective actions as necessary. The DMT Lead will determine the corrective action needed and provide a copy of the checklist to the subsystem lead through the PIC.

The CERES PIC will assign a checklist number to the checklist being used in the audit. The checklist number will consist of the calendar year and a sequential number starting with "01", i.e., 2013-01.

E-5.3 CERES PPQA Action Item Tracking Log

The CERES PPQA Action Item Tracking Log (see Section E-6.9) summarizes deficiencies identified during CERES audits; these deficiencies are initially recorded in audit checklists at the time of the audit by the auditor. Action Item Logs are prepared and maintained by the CERES PIC and is used to track the deficiencies according to AI number until they are resolved. The Action Item (AI) numbers will consist of the checklist number and a sequential number starting with "1", i.e., 2013-01.1. In addition to the AI number, which is first recorded in the appropriate audit checklist by the PIC, the log also includes the following fields for each noncompliance.

- Checklist Type – There is a template for each checklist type in Section E-6.2 through Section E-6.8.
- Action – This is the action required to correct or resolve the identified noncompliance.
- Auditee – Person who was audited and is responsible for resolving the noncompliance.
- Date Opened – The date of the audit where noncompliance was first identified.
- Date Closed – The date the noncompliance was reported as resolved.
- Comments

All items will be resolved as quickly as possible and will be tracked to closure by the CERES PIC. The PIC will work with the Auditee to ensure that the Action Item has been properly resolved. The PIC will review the list of outstanding Action Items and if there are any the PIC will create a new Action Item Tracking Log.

E-5.4 QA Status Report

By the 15th of the month following the end of the semiannual audit period, the CERES PIC will generate the QA Status Report and forward it to the CERES DMT Lead and contract management. The QA Status Report will provide:

- a list of audits completed,
- summary of key findings during the audits, and
- number of action items opened, closed, and pending since the last report.

E-5.5 Record Maintenance

The documents produced as a result of this plan are maintained electronically on the CERES PIC's workstation. Audit checklists will be scanned to allow them to be maintained electronically. Hardcopies of audit checklists and verifiable objective evidence will be stored in the CERES PIC's office.

E-6.0 Templates

E-6.1 Template for the CERES Audit Plan

CERES Audit Plan
Audit Period: month – month year

Subsystem-Level Audits

Subsystem	Subsystem -level Process	Auditee	Auditor	Date	Checklist Number
Instrument					
ERBE-like					
Clouds					
Inversion					
SARB & MOA					
TISA Gridding & GGEO					
TISA Averaging					

Subsystem-level Processes

1. Requirements Management (RM)
2. Production Software Development (PSD)

System-Level Audits

System-level Process	Auditee	Auditor	Date	Checklist Number
Configuration Management				
Measurement and Analysis				
Project Management				

E-6.2 Template for the Requirements Management Audit Checklist

Requirements Management Audit Checklist (Subsystem-level Audit)

Team:	**Checklist Number:**
Auditee:	**Date:**
Position:	**Auditor:**

Audit Elements	Yes	No	N/A	Comments	Action Item #
Were the requirements conveyed by one of the following: CERES PI, WG Chair, or TM?					
Were the requirements conveyed in one of the following ways: face-to-face, phone call, or email?					
Is there an Email containing the requirement or confirming a discussion about the requirement?					
Are the requirements within the scope of the statement of work for the CERES task order?					
Are the requirements implementable within the current schedule and with current resources?					
If the answer to the previous question was no, was the impact provided to the conveyor?					
Is the requirement consistent with the existing software?					
Is an understanding of the requirements demonstrated?					
Is an understanding of the requirements confirmed with the conveyor in an email?					
Have the requirements been entered into the requirement log?					
Has an SCCR been generated for this requirement? (Note: The CM System distributes SCCRs to all relevant stakeholders so they will know what they're committing to.)					
Is the SCCR number included in the requirement log?					
Is the requirement number in the SCCR?					
Is your subsystem's requirement log current?					
Do you follow the Requirements Management Plan?					
Comments: **Total Action Items:**					

Auditee	Auditor	Process Improvement Coordinator
Signature (Date)	Signature (Date)	Signature (Date)

E-6.3 Template for the Production Software Development Audit Checklist

Production Software Development Audit Checklist (Subsystem-level Audit)

Team:	**Checklist Number:**
Auditee:	**Date:**
Position:	**Auditor:**

Audit Elements	Yes	No	N/A	Comments	Action Item #
Is there an SCCR for these changes?					
Is there a prologue, as per the CERES standard, for each software module?					
Was the change history, including the SCCR number, updated in the appropriate software prologue?					
Are Toolkit or CERESlib utilities used for all file open and close actions?					
Are Toolkit utilities used for all error messages and output?					
Have all underflow and overflow conditions been removed from the code?					
Are CERES defaults used for all invalid data?					
Are metadata produced for all CERES data products?					
Is there an interface for all CERES data products in CERESlib?					
Is the subsystem's directory structure consistent with the standard CERES Production directory structure?					
Is the subsystem integrator notified by email that code is ready for integration?					
Were results produced during unit testing replicated with the integrated code?					
Do you have a routine set of integration tests?					
Was the routine set of integration testing successfully completed?					
Did the Science Team provide additional guidance on what data to use for testing?					

Audit Elements	Yes	No	N/A	Comments	Action Item #
Was a Science Team-suggested dataset processed?					
Were sample datasets provided to downstream subsystems for their testing?					
Did the Science Team approve the software updates after reviewing the test results?					
Is the subsystem baseline updated after the last delivery is promoted?					
Do you follow the Software Development Plan?					
Comments: **Total Action Items:**					

Auditee	Auditor	Process Improvement Coordinator
Signature (Date)	Signature (Date)	Signature (Date)

E-6.4 Template for the Configuration Management Audit Checklist

Configuration Management Audit Checklist (System-level Audit)

Team:	**Checklist Number:**
Auditee:	**Date:**
Position:	**Auditor:**

Audit Elements	Yes	No	N/A	Comments	Action Item #
How many subsystem deliveries were received since the last audit?					
Was an SCCR submitted for all deliveries?					
Were all the deliveries received?					
Were all the Delivery Memos received?					
Was all required documentation received?					
Were all the SCCRs approved that resulted in deliveries?					
Were the test cases from the Subsystem's Test Plan successfully executed for all the deliveries?					
Were all the deliveries released to the ASDC?					
Was all required documentation provided to the ASDC?					
Was all required documentation posted on the Web?					
Were all SCCRs associated with promoted software closed?					
Were the final tar files created and stored in the CM code repository?					
Comments: **Total Action Items:**					

Auditee	Auditor	Process Improvement Coordinator
Signature (Date)	Signature (Date)	Signature (Date)

Identify the subsystem and associated SCCRs involved above:

Subsystem	SCCR Number

E-6.5 Template for the Documentation Checklist

Documentation Checklist

Name of Document:
(Release and Version No.) _____

Author: _____

SCCR No.: _____

Date Received: _____

Date Completed: _____

The steps listed below are followed after the document is received from the author and up until the time the document is posted on the Web page:

Item No.	Item	Completed
1	The document is received by e-mail from the author (in a Microsoft Word file that has been downloaded from the appropriate Website). The filename is checked to make sure it follows the guidelines for the proper naming convention and has the correct release and version number.	
2	The document is placed in a working directory.	
3	Normal formatting is checked throughout the document. This includes extra spaces between sentences, paragraphs, using the spell-checker, and just the general looks of the document. Also checking for the correct font sizes and font styles in the tables and making sure no "orphan" lines are left on a page.	
4	The cross-references are checked to make sure that they are hyperlinked to their sources. Sometimes these are highlighted in blue but have not been linked.	
5	The cross-references are also checked to make sure they refer to the right sources. For example: a lot of the authors cut and paste. It is easy to cut and paste and even easier to forget to change the numbers pertaining to that section that it is cut and pasted in.	
6	The headers are checked on each page to make sure the Release and Version number are correct, the date is current, and the document name is correct.	
7	The footers are also checked to make the sure page the numbers are correct and the Appendices begin with the usual A, B, C, etc.	
8	The changebars in the document are checked against the Revision Record to ensure that all changes are recorded accurately. After completion of this step, the changebars are removed from the document.	
9	The Table of Contents, List of Figures, and List of Tables are regenerated in every document. Because of formatting and other modifications, these need to be regenerated each time because a section could shift from one page to another.	
10	A pdf file is created from the Microsoft Word file.	

Item No.	Item	Completed
11	The pdf and word files are then posted on the Website on *wbs128* in their proper directories and the .php file is corrected to indicate the correct date, release number, version number, and filenames. The links on the Web page are then checked to make sure that they are bringing up the proper documents.	
12	The word file that now resides on the appropriate Website is the one that will be downloaded by the author the next time modifications need to be made.	
13	When the Test Plan documents are posted, an e-mail is sent to larc-cerescm@lists.nasa.gov (Tammy Ayers, John Robbins, and Joanne Saunders - SSAI), Jonathan.L.Gleason@nasa.gov (Jonathan L. Gleason - NASA), and the author(s) of the document.	
14	When the Operator's Manual documents are posted, an e-mail is sent to larc-cerescm@lists.nasa.gov (Tammy Ayers, John Robbins, and Joanne Saunders - SSAI), Jonathan.L.Gleason@nasa.gov, (Jonathan L. Gleason - NASA), and to the author(s).	
15	The pdf and word files of the Test Plan and Operator's Manual are e-mailed to Tammy Ayers (SSAI).	
16	The pdf copy of the Test Plan or Operator's Manual is delivered to /SPG_ops/delivery/CERES/incoming/OperatorsManuals or /SPG_ops/delivery/CERES/incoming/TestPlans on *AMI-P* for the ASDC.	

E-6.6 Template for the Measurement and Analysis Audit Checklist

Measurement and Analysis Audit Checklist (System-level Audit)

Team:	**Checklist Number:**
Auditee:	**Date:**
Position:	**Auditor:**

Audit Elements	Yes	No	N/A	Comments	Action Item #
Is the delivery and release date for each SCCR entered by CM in the Delivered Files Tracking Document?					
Are all defects for each SCCR entered by CM into theTRL?					
Are the measurements specified in the Measurement and Analysis Plan included in the QStats Report?					
Has the DMT Lead performed analysis of the measurements?					
Has the DMT Lead included a summary of the analysis in the QStats Report?					
Is the QStats Report distributed as specified in the Measurement and Analysis Plan?					
Have measurement objectives been reviewed, and updated if necessary?					
Is the Measurement and Analysis Plan followed?					
Comments: **Total Action Items:**					

Auditee	Auditor	Process Improvement Coordinator
Signature (Date)	Signature (Date)	Signature (Date)

E-6.7 Template for the Project Management Audit Checklist

Project Management Audit Checklist
(System-level Audit)

Team:	**Checklist Number:**
Auditee:	**Date:**
Position:	**Auditor:**

Audit Elements	Yes	No	N/A	Comments	Action Item #
Is there an approved Technical Response (program plan) in place for the CERES task?					
Is the Software Development staff at its full complement?					
Do all Software Development staff members have access to functioning IT equipment needed to accomplish their tasks?					
Are monthly reports completed and distributed in a timely manner?					
Are Software Development activities provided for inclusion in the Contractor's 6-Month Self-Evaluation?					
Does the Software Development staff support the customer's bi-weekly CPOB meeting by attending and providing status reports?					
Does the Software Development staff meet routinely to monitor progress on meeting requirements and communicate on relevant topics?					
Are status meeting reports distributed to the Software Development staff?					
Do subsystem deliveries to CERES CM follow the posted procedures and adhere to the posted delivery schedules?					
Do all staff members have the required training as specified in the Training Management Plan?					
Do staff members follow the procedures described in the CERES Software Development and Implementation Plan?					
Do you review the productivity of peer reviews? If so, comment on their usefulness.					
Comments: **Total Action Items:**					

Auditee	Auditor	Process Improvement Coordinator
Signature (Date)	Signature (Date)	Signature (Date)

E-6.8 Template for the Process and Product Quality Assurance Audit Checklist

Process and Product Quality Assurance Audit Checklist (Quality Process Audit)

Team:	**Checklist Number:**
Auditee:	**Date:**
Position:	**Auditor:**

Audit Elements	Yes	No	N/A	Comments	Action Item #
Is there an approved Process and Product Quality Assurance Plan in place for CERES Data Management?					
Has a CERES PIC been assigned?					
Is the QA Audit Schedule created for each six-month period and reviewed monthly?					
Are all specified processes reviewed during each six-month period?					
Are specified products reviewed before being transmitted to the customer?					
Are checklists available to guide the auditor?					
Are the checklists numbered with the year and sequential number?					
Do the DMT Lead and subsystem lead (when appropriate) receive the completed checklists?					
Are Action Items from the audit entered into the QA Action Item Log?					
Are Action Items tracked to closure?					
Is the QA Status Report generated each quarter?					
Is the QA Status Report provided to the Program Manager?					
Comments: **Total Action Items:**					

Auditee	Auditor	Process Improvement Coordinator
Signature (Date)	Signature (Date)	Signature (Date)

E-6.9 Template for the CERES PPQA Action Item Tracking Log

CERES PPQA Action Item Tracking Log

AI No.	Checklist Type	Action	Auditee	Date Opened	Date Closed	Comments

E-6.10 Template for QA Status Report

QA Status Report
month - month year

Date: month day, year

1. Audits Completed

   nnn process and nnn product audits were completed during the quarter. Details are provided in Tables 1 and 2.

Table 1. Process Audits Completed

Process	Checklist	Date	Lead

Table 2. Product Audits Completed

Product	SCCR	Date	Author

2. Summary of Key Findings from Audits
   nnn process audits were completed this quarter. nnn discrepancies were noted.

   nnn documents were reviewed this quarter. nnn discrepancies were noted in documents delivered this quarter.

3. Summary of Action Items from Audits
   There are nnn action items still open and nnn that were closed.

Appendix F
Requirements Management Plan

F-1.0 CERES Requirements Management Plan

The purpose of the CERES Requirements Management Plan is to provide guidance on the Requirements Management process in receiving, accepting, and implementing requirements for the development of the CERES science software that will run at the ASDC in the production environment to generate CERES climate-data records.

This document is organized as follows:

Section F-1.0 - CERES Requirements Management Plan
Section F-2.0 - CERES Requirements Management
Section F-3.0 - Requirement Logs

F-1.1 CERES Program Plan

All current software requirements must be traceable back to and within the scope of the Statement of Work as found in the contractor's current task plan or program plan. The contractor's CERES program plan is updated annually. Since this document may be company sensitive, a generic summary of an SOW follows.

> Statement of Work
>
> The contractor will provide support for software design, development, implementation, testing, validation, configuration management, and documentation for processing and analyzing CERES data from multiple instruments, including both pre-launch testing and on-orbit operations. Subsystem's code, as directed by the respective Subsystem Working Group Chair, will accept inputs from the various satellite instruments to produce consistent CERES data products. Consistent with requirements and priorities established by the CERES Subsystem Working Group Chairpersons, the contractor will perform code development and maintenance for production and analysis codes. The operational code must execute correctly on both the *AMI-SCF* and *AMI-P*. The contractor will support production code deliveries to the ASDC for data product production in accordance with the CERES Production Software Development and Implementation Plan.

F-1.2 Algorithm Theoretical Basis Documents

The CERES ATBDs (see Reference 11) were written by the CERES Science Team to describe the scientific calculations to be implemented in the production software before the first instrument launch. From the ATBDs and other information provided by the DMT Lead a complete set (one for each CERES subsystem) of CERES Software Requirements Documents (see Reference 9) were produced. The Software Requirements Documents served as a basis for the initial software design and guided the Release 1, the prelaunch version, subsystem development. Subsequent software releases included updated algorithms based on new

requirements from the Science Team. Instead of following updates to these ATBDs, since about 2005, requirements for changing the CERES production code and the implementation of those requirements follow the processes described in this Requirements Management Plan.

F-2.0 CERES Requirements Management

The following tables describe the tasks associated with Requirements Management: demonstrate how requirements are conveyed and received by SDT personnel, how understanding of the requirements is demonstrated, the acceptance criteria, and the feedback mechanism for confirming with the customer that the requirements have been received, understood, and the action that will be taken to implement the requirements. All requirements are entered into subsystem Requirements Logs (see Reference 22) upon receipt, and an SCCR (see Section B-2.1.1) is created if one does not exist. The SCCR is updated before delivery to capture additional requirements received for that delivery.

Table F-2-1. Convey Science and System Requirements

Conveyance Mechanism	Description
Face-to-Face Meetings	Many of the CERES software requirements and changes to those requirements are conveyed to the software development teams though various meetings. The CERES Science Team Meetings and associated WG sessions are formally documented in the CERES Science Team Meeting Minutes (see Reference 23) and (see Reference 24). Occasionally, the CERES PI will hold "local" but more formal meetings with the WG chairs and SDT staff. Some WG chairs have periodic meetings with their teams. Members of the SDT staff attend meetings with their WG chair or other members of the CERES Science Team. Regular biweekly meetings of the CERES Production Oversight Board (minutes for these meetings are approved by the DMT Lead) (see Reference 25). Requirements not documented in meeting minutes need to be acknowledged in an email to the PI, WG chair, or DMT Lead or in action item logs.
Phone Calls	Phone calls are often made between Science Team or DMT Lead and members of the SDT, typically a subsystem lead, to discuss implementation of requirements or changes to them. Requirements received by this method are documented by an email to the conveyor.
Email	Requirements and changes to requirements also can come by Emails. This email is the first level of documentation for the requirement.

Table F-2-2. Obtain an Understanding of Requirements

Evaluation Criteria	Questions to Answer Affirmatively
Clearly Stated	Emails, meeting minutes, and personal notes should be reviewed to ensure that all relevant information has been documented. Is the request unambiguous? Was it stated as a needed capability as opposed to a software solution?
Complete	After having time to think about the requirement, have all questions about the requirement been answered? Are the effects known on all other calculations or procedures impacted by the change? Do you know exactly what will need to be changed?
Consistent	Are the new requirements consistent with existing software requirements?

Table F-2-2. Obtain an Understanding of Requirements

Evaluation Criteria	Questions to Answer Affirmatively
Implicit Assumptions	Have all implicit, not identified, requirements that need to be implemented in conjunction with this requirement been identified? Some implicit assumption might result in a new data set, additional error checking, or existing interface or data product being changed.
Appropriate	The requirement should be evaluated in terms of the overall and subsystem objectives. Is this subsystem the best place to implement the requirement?
Verifiable	Can a method to verify the requirement be determined? Are there answers to any question this process generates?
Restate	Can you describe the requirement in your own words? An email or document will be sent to the requirement conveyor and other impacted stakeholders stating the understanding of the requirement.

Table F-2-3. Accept Requirements

Category	Acceptance Criteria
SOW	Proposed requirements or requirement changes must be within the scope of the SOW (see Section F-1.1).
Source	Software development requirements can be accepted only when received from or approved by one or more of the following and in accordance with the conveyance methods described in Table F-2-1. a. the CERES Principal Investigator or a duly assigned representative, b. CERES Science Team WG Chairs or a duly assigned representative, c. the CERES DMT Lead or a duly assigned representative.
Schedule	Proposed requirements or requirement changes must be consistent with CERES DP schedule as maintained by CERES CM in the current CM schedule which is available through the CERES CM Website (see Reference 16). The impact of proposed requirements or requirement changes that are NOT consistent with the DP schedule must be evaluated and the results of this evaluation must be provided to the conveyor of the requirement before it is accepted. The conveyor can defer a requirement to a latter delivery.
Other Resources	Proposed requirements or requirement changes must be consistent with personnel, computational, and other resources. The impact of proposed requirements or requirement changes that are NOT consistent with the necessary resources needed to satisfy the requirement must be evaluated and the results of this evaluation provided to the conveyor of the requirement before acceptance. The conveyor can request additional resources from the PI or defer a requirement to a latter delivery.
Targeted Software	Proposed requirements or requirement changes must be consistent with existing software that needs to implement it. If not, approval from the PI, WG Chairs, and DMT Lead will be needed before new software development is done.

Table F-2-4. Obtain Commitment to Requirements

Method	Description
Email	As described in Table F-2-1, email is sent to the requirement conveyor to confirm the receipt of the requirement. In addition to confirming the receipt of the requirement, where appropriate, this or a different email may be sent to the requirement conveyor explaining the subsystem developer understanding and interpretation of the requirement Table F-2-2. The near-term and long-term implementation strategy for the requirement is also described, especially any impact to other efforts.
SCCR	An SCCR is opened by the appropriate subsystem lead when the software development team receives the first requirement. SCCRs are emailed to the entire SDT and to the appropriate Science Team WG. The SCCR is discussed at a biweekly meeting of the CCB (see Section B-1.2) during the CPOB meeting. The CCB chair approves or disapproves the SCCR. If necessary at the end of software development activity and before the resulting modified or new software is delivered to CM, the SCCR is updated to reflect in more detail the nature of the science changes, non-science changes, and parameter changes that actually resulted from implementing all accepted requirements and changes to the requirements.
Software	Members of the WG can obtain a copy of the completed software.
Test Results	The result from CM testing following the subsystem's specific Test Plan is recorded in the TRL.

Table F-2-5. Response to Conveyor

Documents	Description
Email	Email is sent to the requirement conveyor to confirm receipt of the requirement, to verify the interpretation and understanding of the requirement, and to describe the near-term and long-term implementation strategy for the requirement.
SCCR	The requirement conveyor is on a distribution list that will receive an email message containing the complete SCCR when the pertinent SCCR is submitted. An Email is sent for subsequent updates to the SCCR. This keeps all parties advised of the implementation status of the requirement. Any stakeholder can view the SCCR through the CERES CM Website.
Requirements Log	All stakeholders have access to the CERES Requirements Log Website. Requirement providers should be able to confirm when the requirement they provided was received and accepted.

Table F-2-6. Maintain Bidirectional Traceability of Requirements

Documents	Traceability
Requirements Log	The major requirement is identified in the subsystems Requirements Log with the subsystem and a single number. Sub-requirements that are derived from the major requirement are indicated with a decimal and number from the major requirement. The requirement is associated with a SCCR number in the Requirements Log.
SCCR	The SCCR will contain the requirement number for each change that is implemented. The SCCR will list addition, deletions, or changes of parameters.
Biweekly CPOB Meeting Status Reports	Updates provided to the SDT that are tied to requirements will have the requirement and SCCR number listed.
Prologues	The prologue in each module, function, or subroutine will identify the SCCR in the description of the change.
Program Plan	CERES is in the maintenance phase so most modifications do not require much time. The Program Plan provides system-level guidance and resource allocation.

Table F-2-7. Identify Inconsistencies between Requirements

Methods	Comments
CPOB Meeting	During the biweekly CPOB meeting, the production priority, delivery schedule, work tasks, and SCCRs are discussed. This allows insight to those attending, representatives from the CERES DMT Lead, task management, each subsystem team, CM team, and ASDC, on current requirements. The representatives are encouraged to speak about impacts to their subsystem or production
SCCR Email	When an SCCR is created or updated, an auto generated email is sent to the Science WG Chair and SDT. After reviewing the information, the recipients are encouraged to respond about any inconsistencies they identify.
Science Team Meetings (formal and informal)	The CERES PI and Science WG Chairs hold meetings that are attended by SDT members to determine impacts that changes in the CERES data products have on users and downstream subsystems.
Contract Program Manager	The contract program manager reviews the monthly report that includes information on SCCR status in the CM section. Subsystems will report progress on implementing requirements in their section. CERES task management has regular meetings with the program manager to discuss progress and issues with the SDT.
Science Testing	The Science WG Chairs review CERES data products while the requirements are implemented. Their approval is needed before the software can be delivered.
CM Testing	CM maintains the TRLs that record problems that occur during CM testing.

F-3.0 Requirements Logs

CERES software requirements are generally provided to specific CERES subsystem teams. A list of the CERES subsystem groupings for requirement purposes follows:

1. Instrument (Subsystem 1)
2. ERBE-like (Subsystems 2 and 3)
3. Clouds (Subsystems 4.1 through 4.4)
4. Inversion (Subsystems 4.5 and 4.6)
5. Instantaneous and Synoptic SARB (Subsystems 5 and 7.2)
6. TISA Gridding (Subsystems 6 and 9)
7. TISA Averaging (Subsystems 7.1, 8, and 10)
8. GGEO (Subsystem 11)
9. MOA (Subsystem 12)

Requirements Logs are maintained by each CERES subsystem and contain the fields listed in the following table.

Table F-3-1. Fields in a CERES Requirements Log

Field Number	Field Description
1	Requirement Number
2	Requirement
3	SCCR
4	Provider
5	Responsible Subsystem
6	Responsible Person
7	Method the new requirement was conveyed to the subsystem team
8	When was the new requirement received by the subsystem team
9	When was the new requirement accepted by the subsystem team
10	When was the requirement completed
11	The current status of the requirement

The procedure for updating a subsystem requirements log follows.

CERES Subsystem Lead

1. Retrieve the current version of the document from the CERES Requirements Logs Website (see Reference 22).
2. Make modifications to the document. A new requirement will also require a SCCR to be open. The first requirement defines the purpose of the delivery such as a new Edition or migration to different computer hardware. Subsequent sub-requirements providing details on specific changes such as a new algorithm for a specific parameter or production

system change are entered into the requirements' log under their "parent" requirement. Status of open requirements should be updated.
3. Email the document to the CERES Documentation Team.

CERES Documentation Team

1. Version control - confirm the baseline of the modified document is as expected
2. Review the document and ensure compliance with standards
3. Update the version number
4. Create PDF version
5. Post a copy of the revised Requirements Log on the CERES Requirements Log Website
6. Store a copy of the document into the CERES documentation repository
7. Replace the CERES Requirements Log Web link to the updated document

On a biweekly basis a request for input to the biweekly CPOB Meeting Status Report is sent to all subsystem team members. Included in this input is the status of ongoing activities in support of recorded subsystem requirements.